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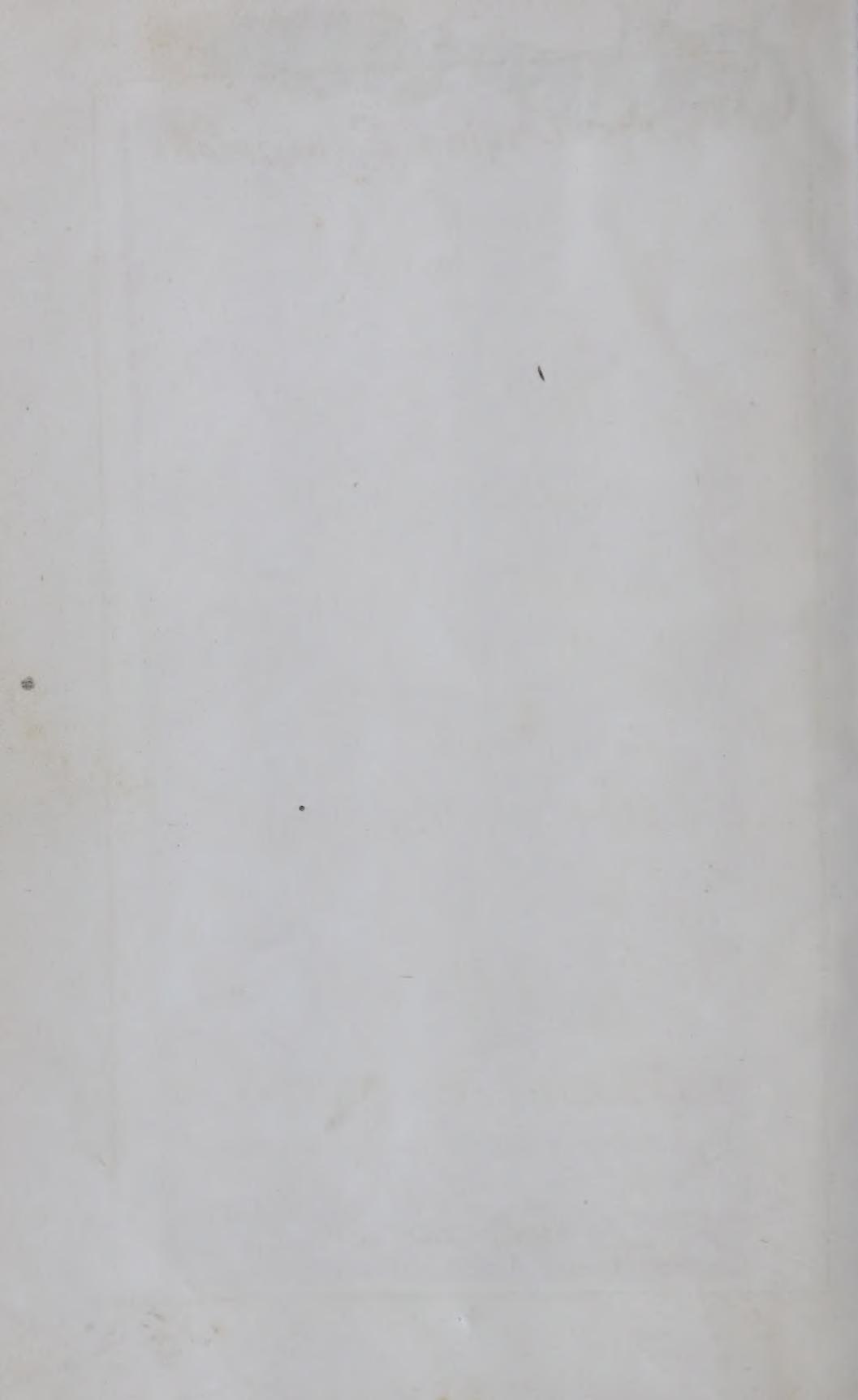
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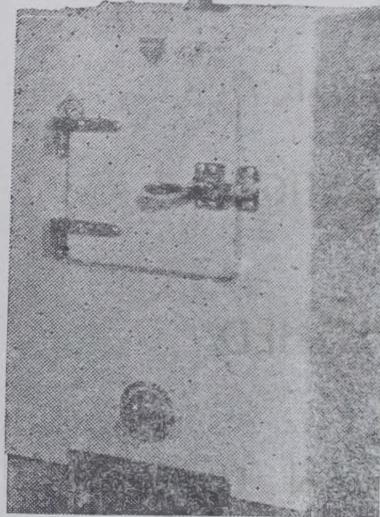
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ANNUAL REVIEW OF BIOCHEMICAL
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VOL. XXIII, 1952

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CHROMATOGRAPHY

K. V. GIRI AND A. L. N. PRASAD

*Department of Biochemistry
Indian Institute of Science, Bangalore*

Many important contributions to chromatography have been made during the past three years, the period covered by this review. Particular mention may be made here of the development of a paper chromatographic technique for the separation and identification of enzymes, and of the development and extensive application of the now familiar circular paper chromatographic technique for the qualitative and quantitative analysis of various classes of substances like amino acids, sugars, organic acids, etc. In addition, there have been numerous applications of the conventional ascending and descending uni- and two-dimensional paper partition chromatography.

Paper Chromatography:

Techniques

Giri and Prasad^{1,2} and Giri *et al*³ developed a technique for identification and separation of enzymes by paper chromatography. They showed that enzymes could be made to move on paper by employing aqueous acetone or alcohol or salt solutions as the developing solvents. The position of the enzymes on the developed chromatograms was located by the agar plate method. This consisted in placing the paper containing the enzyme, after irrigation with the solvent, on an agar plate impregnated with a suitable substrate. After allowing about 8 to 12 hours for the enzyme to react with the substrate, the paper was carefully removed from the surface of the agar plate and flooded with an appropriate reagent

1. Giri, K. V. and Prasad, A. L. N. (1951), *Nature*, **167**, 859.

2. Giri, K. V. and Prasad, A. L. N. (1951), *Nature*, **168**, 786.

3. Giri, K. V., Prasad, A. L. N., Gowri Devi, S. and Sri Ram, J. (1952), *Biochem. J.*, **51**, 123.

which produced colour either with the substrate or its breakdown products. The position of the enzymes could then be ascertained from the coloured or colourless spots appearing on a colourless or coloured background. Using this technique, the authors studied the chromatographic behaviour of amylases, phosphorylase, and phosphatases. For proteinases like trypsin the developed chromatogram was placed on the gelatin side of an unexposed cine-film strip and after moistening, was placed in an incubator at 37°C. for a short while. After removing the paper from the film strip a transparent zone could be seen corresponding to the position of the enzyme on the paper. With the help of these techniques it was shown that while certain enzymes like the amylase from *Aspergillus niger*, phosphorylase from green gram, phosphatases (acid and alkaline) from rat, sheep or pig kidney, and trypsin had high R_f values; certain other enzymes like salivary amylase, amylase from a commercial trypsin preparation, and one of the alkaline phosphatases of kidney, did not move. Mixtures of enzymes like amylases of saliva and *Aspergillus niger*, the alkaline phosphatases of kidney, and amylase and trypsin of a commercial trypsin preparation were successfully separated.

Venkatesh and Sreenivasaya⁴ applied the auto-biographic technique for the location of 'Physiologically Active spots on papyrograms.' The method was applicable to the location of substances like vitamins, antibiotics and other growth factors on developed papyrograms. This was achieved by placing the paper strips on an agar surface inoculated with suitable bacteria, e.g., *S. aureus* for the pencillins. After incubation, the paper strip was removed from the agar surface, when transparent zones indicating the position of the active spots, were seen on the agar surface. The area of the zone gave an approximate measure of the quantity of the active substance present.

Rao and Beri⁵ described a method, which they designate as 'horizontal migration method' for the separation of sugars. The technique was essentially the same as that of Rutter, with the slight

4. Venkatesh, D. S. and Sreenivasaya, M. (1951), Current Science, **20**, 98.

5. Rao, P. S. and Beri, R. M. (1951), Proc. Indian Acad. Sciences, **33-A**, 368.

modification of cutting the 'tail' to about 1.5 cm from the centre instead of making the parallel cuts from the centre right to the edge as suggested by Rutter. The authors stated that the sugars in a mixture could be identified by their R_f values. It is, however, desirable to run known sugars on the same paper for identification of the unknown sugars with assurance. This can not be done by adopting the technique described by the authors. The technique of carrying out mixed chromatograms for the identification of substances by circular paper chromatographic technique has been described by Giri and Rao ^{8,9}.

In a subsequent paper⁶ Rao *et al* applied the horizontal migration method of filter paper chromatography to the separation and identification of glucuronic acid and galacturonic acid and their barium salts.

Giri⁷ and Giri and Rao^{8,9} developed new techniques for the chromatographic analysis of various substances using circular filter papers. The method, in its simplest form, consisted of applying the test solution as a spot at the centre of a circular filter paper, and inserting a folded paper strip into a longitudinal cut of about $\frac{1}{2}$ cm. length made at the centre, the free end of this strip dipping into the solvent contained in a small cup placed in a petri dish. The provision of a detatchable 'wick' for irrigating the paper with the solvent was advantageous and convenient. It ensured a more uniform distribution of the substances along their respective zones in contrast to the uneven distribution obtained when circular filter paper discs with a tail cut out of them were used, as suggested by Rutter and Rao and Beri.

The circular filter paper chromatographic technique as described above is a simple, elegant and rapid method for the separation and identification of many substances like amino acids, organic acids, sugars, etc. Its chief drawback was that only one spot could be placed and analysed. The authors overcame this

6. Rao, P. S., Beri, R. M. and Rao, P. R. (1951), Proc. Indian Acad. Sciences, **34A**, 236.

7. Giri, K. V. (1951), Current Science, **20**, 295.

8. Giri, K. V. and Rao, N. A. N. (1952), Nature, **169**, 923.

9. Giri, K. V. and Rao, N. A. N. (1952), Jour. Indian Inst. Science, **34**, 95.

difficulty and were able to run mixed chromatograms with circular paper by a simple modification. The test spot, instead of being applied to the filter paper disc at its centre, was applied at one point on the circumference of a circle of about 2-4 cm. diameter drawn from the centre of the paper disc. At convenient intervals other spots either of the test solution of a different concentration or of a different test solution or a solution containing a known mixture of substances could be applied on the circumference of the small circle. After running the chromatogram and developing the colours, the location of the substances was indicated by the coloured concentric arcs formed. The substances present in the unknown sample could be easily identified by reference to the arc of the known substance formed on the circumference of the same circle.

The authors first applied this circular paper chromatographic technique to the study of the chromatographic behaviour of amino acids. They employed n-butanol-acetic acid-water in the ratio 40 : 10 : 50, as the developing solvent and a 0.1% solution of ninhydrin in acetone as the spraying reagent. They found that though the R_f values of the amino acids were subject to variations depending on the experimental conditions, the relative rates of movement of the amino acids were always found to be constant, provided the same solvent was used.

Some of the amino acids (lysine-histidine, asparagine-arginine, serine-glycine-aspartic acid, valine-methionine and leucines) overlap each other and so their identification is rendered difficult on first development. By repeating the development (multiple development technique), however, distinct improvement on the separation of some of the overlapping amino acids can be obtained.

Giri *et al*¹⁰ evolved a simple method for the quantitative estimation of amino acids separated by circular paper chromatography. For quantitative estimation, the amino acids on the developed chromatogram were stained by spraying with 0.5% ninhydrin in acetone and the paper was kept for drying at 65°C. for about 15 minutes. The individual bands so obtained were

10. Giri, K. V., Krishnamurthy, K. and Venkitasubramanian, T. A. (1952), *Current Science*, **21**, 44.

then cut out and placed in test-tubes containing 4 ml. of 75% alcohol. In a few minutes the colour was completely extracted from the paper by the alcohol, so much so that reading of the intensity of the colour of the alcoholic extract by a Klett-Summerson photoelectric colorimeter and referring to the calibration curve drawn for the particular amino acid in question gave the quantity of the amino acid present in the test solution.

Subsequently Giri *et al*¹¹ in a detailed investigation on some factors influencing the quantitative determination of amino acids separated by circular paper chromatography showed that the tone and intensity of the colour of the alcoholic extracts of the ninhydrin-stained bands were markedly affected by traces of copper. They found that the bluish violet colour of the alcoholic eluate of the band was changed to reddish purple colour by the addition of copper sulphate. The optimum concentration of copper sulphate was shown to be 0.2 mg. CuSO₄, 5H₂O in 4 ml. of the alcoholic eluate. They also found that the intensity of the colour of the ninhydrin-stained bands increased with increase in the area of the bands. Based on the above observations the authors recommended that for obtaining accurate quantitative results the ninhydrin-stained bands should be extracted with 4 ml. of 75% alcohol containing 0.2 mg. of CuSO₄, 5 H₂O, and that a standard mixture containing known concentrations of amino acids should be run on the same chromatogram along with the test solutions for the purpose of comparison.

An ingenious method for obtaining a two-dimensional circular paper chromatogram was recently developed by Airan¹². A ring of Whatman No. 1, 0.5 cm. in width and 6 cms. in outer diameter, was cut out, keeping a tail to dip into the developing solvent. The test solution was spotted on the paper ring near the tail so that, on developing the chromatogram, the substances in the test solution well spread out circularly along the ring. The ring was then stitched on to a 24 cms. Whatman No. 1 circular paper and the chromatogram

11. Giri, K. V., Radhakrishnan, A. N. and Vaidyanathan, C. S. (1952), *Analytical Chemistry*, **24**, 1677.

12. Airan, J. W. (1953), *Current Science*, **22**, 51.

gram obtained as usual. The substances were found to spread out as bands whose outer tips formed a spiral.

Radhakrishnamurthy and Sarma¹³ achieved a better separation of amino acids and sugars with close *Rf* values, by a modification of the ascending paper chromatographic technique. Their method consisted in placing a pad of filter paper discs on the top of the filter paper cylinder to provide extra capillary action. They showed that a 72-hour run for sugars and a 48-hour run for amino acids effected a maximum separation and a minimum of diffusion of the constituents.

Applications

Giri *et al* ^{14, 14 (a)} applied the circular paper chromatographic technique to the qualitative study of the amino acid composition of several proteins, *viz.*, casein, gelatin, silk fibroin, zein, rice protein, egg albumin, whole egg protein, and protein from cambu. The proteins were hydrolysed by 6N HCl in an autoclave at a pressure of 15 lbs. for 6 hours. By running circular chromatograms with the hydrolysates and employing specific colour reactions for some of the overlapping amino acids they were able to show the presence of all the amino acids reported in literature in each of the protein hydrolysate. By visual comparison of the intensities of the amino acid bands obtained in a mixed chromatogram of the protein hydrolysates they showed that gelatin contained less tyrosine than casein, silk protein, rice protein and zein; that silk protein was very low in leucines and other fast running amino acids compared to other protein; and that glycine, serine and alanine were predominant in silk protein.

Krishnamurthy *et al*¹⁵ showed by circular paper chromatographic analysis of the amino acids of tea and coffee infusions that while the coffee infusion contained very insignificant amounts of

13. Radhakrishnamurthy, R. and Sarma, P.S., *J. Sci. and Indust. Res., India*, **11B**, 279.

14. Giri, K.V., Krishnamurthy, K. and Venkitasubramanian, T.A. (1952), *Current Science*, **21**, 11.

14. (a) Giri, K. V., Krishnamurthy, K. and Venkitasubramanian, T. A. (1952), *J. Indian Inst. Science*, **34**, 209.

15. Krishnamurthy, K., Venkitasubramanian, T.A. and Giri, K. V. (1952), *Current Science*, **21**, 133.

amino acids, tea infusion contained considerable amounts of amino acids besides a mono-ester of glutamic acid.

Krishnamurthy *et al*¹⁶ found that keeping the chromatograms, immediately after developing colour with ninhydrin, in a vacuum desiccator over fused CaCl_2 preserved the tone and colour intensity of the bands for more than two months.

Nandi and Rajagopalan¹⁷ compared the amino acid make up of cow's and vegetable milk by circular paper chromatography and found no marked differences in their compositions.

Giri *et al*¹⁸ applied the circular paper chromatographic technique to the study of the amino acid make up of blood and showed that normal blood contains the following amino acids: leucines, methionine, valine, alanine, lysine, histidine, tyrosine, glutamic acid, threonine, glycine, arginine, cystine, serine, and glutamine.

Krishnamurthy and Venkitasubramanian¹⁹ applied the circular paper chromatographic technique to the separation of sugars in fruits and honey. They showed that orange, lemon, sweet lemon, banana, as well as honey contained glucose, fructose and sucrose.

Giri *et al*^{20,21} applied the circular paper chromatographic technique for the detection of transamination reactions and showed that the following transminase systems occur in aqueous extracts of green-gram (*Phaseolus radiatus*).

- (1) alanine + α -ketoglutarate \rightarrow glutamic acid + pyruvate;
- (2) glutamic acid + pyruvate \rightarrow alanine + α -ketoglutarate;
- (3) aspartic acid + ketoglutarate \rightarrow glutamic acid + oxalacetate.

(Miss) Tara Rao and Giri²² made a detailed investigation

16. Krishnamurthy, K., Venkitasubramanian, T. A. and Giri, K.V. (1952), *Current Science*, **21**, 252.

17. Nandi, D. K. and Rajagopalan, R. (1952), *Ibid.*, **21**, 250.

18. Giri, K. V., Krishnamurthy, K. and Venkitasubramanian, T. A. (1952), *Lancet*, **562**.

19. Krishnamurthy, K. and Venkitasubramanian, T. A. (1952), *Current Science*, **21**, 278.

20. Giri, K. V., Radhakrishnan, A. N. and Vaidyanathan, C. S. (1952), *Nature*, **170**, 1025.

21. *Idem* (1952), *J. Indian Inst. Science*, **34**, 305.

22. Tara Rao and Giri, K. V. (1953), *Ibid.*, **35**, 77.

on the R_f values of a number of amino acids on circular chromatograms in various solvents, *viz.*, n-butanol-acetic acid-water, phenol and mesityl oxide. They found that the R_f values of amino acids as determined by the circular paper chromatographic technique were higher than those obtained by the unidimensional chromatographic techniques. They also determined the R_f values of the amino acids using acetone-water, in various proportions, as developing solvents and found that the addition of a larger proportion of water to acetone caused the amino acids to travel more rapidly on the chromatograms. Further, they found that temperature, and increase in the concentration of amino acid applied to the paper from 0.1% to 2.4% had no effect on the R_f values, while the R_f values of amino acids increased up to a certain point with increase in the distance travelled by the solvent front and decreased with increase in the distance of the initial spot from the centre of the paper.

Giri *et al* ²³ extended the circular paper chromatographic technique to the separation of organic acids and in that connection determined the R_f values of the organic acids (glycollic, oxalic, tartaric, citric, malic, malonic, tricarballylic, lactic, succinic, fumaric, and adipic acids) in various solvents like n-butanol-formic acid-water (10 : 2 : 5 and 15 : 10.5 : 15), n-butanol-acetic acid-water (4 : 1 : 5), etc. In general, they found that the R_f values obtained by the circular paper chromatography were higher than those obtained by unidimensional chromatography. Further, it was observed that n-butanol-formic acid-water (15 : 10.5 : 15) was the best solvent for obtaining a good separation of the organic acids. By using this method, the authors showed that unripe mangoes (sour variety) contained oxalic, malic, citric and succinic acids, besides two unidentified acids.

Govindarajan and Sreenivasaya ²⁴ used the ascending chromatographic technique for studying the organic acid make up of fermented beers. They employed n-butanol-acetic acid-water as the developing solvent. By correlating the acids produced in beers fermented by micro-organisms with the type of strains and

23. Giri, K. V., Krishnamurthy, D. V., and Narasimha Rao, P. L. (1953), *J. Indian Inst. Science*, **35**, 93.

24. Govindarajan, V. S. and Sreenivasaya, M. (1950), *Current Science*, **19**, 269.

fungi employed, the authors were able to classify some micro-organisms with respect to their capacity to produce organic acids.

Govindarajan and Sreenivasaya²⁵ studied the free amino acid make up of four common varieties of mangoes by the chromatographic technique.

Govindarajan and Sreenivasaya²⁶ critically examined the micro paper chromatographic technique of Rockland and Dunn with a view to employing it for studies on the nitrogen metabolism of micro-organisms and confirmed the findings of Rockland and Dunn that microgram quantities of amino acids could be detected by their method.

Govindarajan and Sreenivasaya²⁷ studied the organic acid make up of acid-alcoholic extracts of tamarind leaves and the leaves and stems of *Oxalis corniculata*. They found that tamarind leaves contained tartaric acid and a larger amount of malic acid, while *Oxalis corniculata* leaves contained a large amount of tartaric acid and comparatively smaller amounts of citric, malic, and oxalic acids and an unidentified acid with an R_f value of 0.9.

Sirsi *et al*²⁸ separated the active principle of *Toddellia aculeata* (a reputed specific for dysentery) by the ascending chromatographic technique, using water saturated ether as the developing solvent. They found that the active principle was adjacent to the chlorophyll band.

Bhimeswar and Sreenivasaya²⁹ studied the relative rates of movement on paper of adenine, guanine, uracil and xanthine by the ascending technique. They found that ethyl alcohol-0.5N HCl (2:1) and n-propanol-HCl gave good separation of the above substances.

Rao and Beri³⁰ determined the R_f values of sugars by the ascending chromatographic method and found them to be in general agreement with the values obtained by Partridge by descending chromatography.

25. Govindarajan, V.S. and Sreenivasaya, M. (1950), Current Sci., **19**, 234.

26. *Idem*, (1950) *Ibid.*, **19**, 39

27. *Idem*, (1951) *Ibid.*, **20**, 43.

28. Sirsi, M., Venkatesh, D. S., Bhimeswar, B. and Sreenivasaya, M. (1951), *Ibid.*, **20** 126.

29. Bhimeswar, B. and Sreenivasaya, M. (1951), *Ibid.*, **20**, 61.

30. Rao, P. S. and Beri, R. M. (1951), *Ibid.*, **20** 99.

Kalyankar *et al*³¹ determined the *Rf* values of a number of organic acids by the ascending chromatographic technique and found that n-butanol-formic acid-water (10 : 2 : 5) gave the best separations of the acids. Using this method, the authors analysed the organic acid make up of a number of fruits. They showed that of the citrus fruits, *Citrus limonium*, contained the highest amount of citric acid (74%) and a surprisingly high oxalic acid content (20%). Of the non-citrus fruits, the acid variety of pomogranate contained 95% citric acid with a trace of oxalic acid. Tamarind contained 85% tartaric and 15% malic acids.

Srinivasan and Vijayaraghavan³² confirmed the presence of threonine in Bengal gram by paper chromatography of the sulphuric acid hydrolysate of defatted Bengal gram.

Bose and Burma³³ analysed the sugars present in jute hemicellulose by one way descending chromatography. The hemicellulose was first hydrolysed with sulphuric acid and after removal of the acid from the hydrolysate, the chromatography was carried out. Glucose, fructose, arabinose, galactose, xylose, rhamnose and mannose (?) were shown to be present. Galacturonic acid and glucuronic acid were not found probably due to their decarboxylation and subsequent conversion to arabinose and xylose during hydrolysis.

Das *et al*³⁴ by hydrolysing jute hemicellulose with formic acid and carrying out unidimensional descending chromatography with phenol-water and butanol-water as developing solvents showed the presence of glucuronic acid besides the sugars, xylose, arabinose, and rhamnose. The above constituent substances were separated by running long chromatograms on Whatman No. 3, cutting out the spots, eluting the substances, evaporating the solutions and identifying by colour tests. Xylo-glucuronic acid was also shown to be present.

31. Kalyankar, G. D., Krishnaswamy, P. R. and Sreenivasaya, M. (1952), Current Science, **21**, 220.

32. Srinivasan, P. R. and Vijayaraghavan, P. K. (1952), *Ibid.*, **21**, 101.

33. Bose, R. K. and Burma, D. P. (1952), Science and Culture, **18**, 39.

34. Das, D. B. Roy Chowdhury, P. K. and Wareham, J. F. (1952), *Ibid.*, **18**, 197.

Das *et al*³⁵ established that considerable amounts of xylan were present in α -cellulose obtained from jute by the chlorite method. The presence of xylan was shown by partition chromatography of the formic acid hydrolysate of α -cellulose. Also, since different fractions obtained by the fractional hydrolysis of α -cellulose with formic acid gave spots for both xylose and glucose and none for uronic acid, it was concluded that xylan was tenaciously associated with α -cellulose of jute.

Bose³⁶ showed by paper chromatography that galacturonic acid was the main constituent of the break down product of the action of five different poly-galacturonases, prepared from fungi, on jute and citrus pectin of low methoxyl content.

Airan³⁷ separated the cations, Cu, Co, and Ni by circular paper chromatography of the chlorides, using butanol-acetic acid-water as the developing solvent, and 0.1% solution of rubenic acid in 6% alcohol as the spraying reagent. As compared with the separation obtained by ascending chromatography, the circular paper chromatographic technique gave a better separation of Ni and Co which travel close together.

Airan and Barnbas³⁸ separated the chlorides of Cu, Co, and Ni by circular paper chromatography using methyl ethyl ketone-HCl (75:25) as the developing solvent and 0.1% solution of rubenic acid, as also H_2S gas, as the spraying reagents.

Chakrabarti and Burma³⁹ studied the rate of movement of the alkali metal chlorides (Li, Na, K) in ascending and descending chromatography using various solvents like absolute methyl and ethyl alcohols, acetone, and aqueous solutions of ethyl alcohol and acetone as the developing solvents. While the alkali chlorides moved in the case of absolute methyl alcohol, they did not at all move in acetone and absolute ethyl alcohol. They, however, moved in the aqueous solutions-K having the least R_f value and Li the highest R_f value.

35. Das, D. B., Mitra, M. K. and Wareham, J. F. (1952) Science and Culture, **18**, 249.

36. Bose, R. K. (1953), *Ibid.*, **18**, 394.

37. Airan, A. W., (1952), *Ibid.*, **18**, 89.

38. Airan, A. W. and Barnbas, J. (1953), *Ibid.*, **18**, 438.

39. Chakrabarti, S. and Burma, D. P. (1951), *Ibid.*, **18** 415.

Rao and Beri ⁴⁰ determined the R_f values of amino acids in various solvents by what they call "horizontal migration chromatography" which is more or less the same as Rutter's technique using circular paper discs. In contrast to the findings of Giri, they obtained different R_f values for the amino acids in butanol-acetic acid-water as the developing solvent and found their R_f values to be much different from those obtained by ascending or descending chromatography. Apart from the differences in the R_f values, they obtained a relative order of the rate of movement of the amino acids somewhat different from that reported by Giri and his co-workers. The relative position of some of the amino acids (glutamic acid, cystine, arginine, histidine) on the chromatogram as indicated by the R_f values reported by the authors were surprisingly different from those reported by other workers. These values deserve further verification.

The authors claim that amino acids can be identified easily by their R_f values. Experience of others has shown that the exact reproduction of R_f values is very difficult as the values are influenced by various factors, such as type of paper, temperature, the nature of the solvent, the distance of the solvent front, pH, etc. It also varies from batch to batch of paper used and as such identification of amino acids by R_f values alone without running simultaneous controls with known amino acids on the same paper is not reliable. In a paper published by Tara Rao and Giri ²² these points have been discussed in detail.

Burma and Banerjee ⁴¹ and Burma ⁴² studied the rates of movement of amino acids in ascending paper chromatography using iso-propylalcohol-water, n-butanol-acetic acid-water, amyl alcohol-acetic acid-water and benzyl-alcohol-acetic acid-water of varying compositions as the developing solvents. They found that, in general, R_f values increased with increase in water content while the differentiation between individual amino acids decreased with too much increase in the water content of the solvent.

40. Rao, P. S. and Beri, R. M. (1952), Proc. Indian Acad. Sci., **36A**, 371.
 41. Burma, D. P. and Banerjee, B. (1951), J. Indian Chem. Soc., **28**, 135.
 42. Burma, D. P. (1951), *Ibid.*, **28**, 555.

Burma⁴³ showed that in the descending as well as ascending methods of chromatography, the R_f values gradually decreased with increase in the distance of the initial spot from the starting point. This was attributed to the decrease in the water content of the developing solvent during its movement along the paper. This behaviour was explained from the standpoint of the partition mechanism of paper chromatography.

Rao *et al*⁴⁴ separated mixtures of dyes by dipping rectangular sheets of paper with a short stem in the middle into the dye solution and then into the solvent. They also showed that direct dyes could be separated on cellulose acetate, nylon or vinyon fabrics after suitable activation. Chrysophenine-CH, congo red and Durazol fast blue-G. S. were thus separated using water as the developing solvent.

Roberts and Wood⁴⁵ made a detailed study of the polyphenols in tea leaf by using the two-dimensional paper chromatographic technique. They showed that tea leaf contained both epimers of catechin and gallo-catechin, with their galloyl esters besides gallic acid and probably m-digallic acid. Boiling a tea leaf infusion resulted in the epimerization of the simple catechins and a transformation of the galloyl esters. During fermentation the various catechins were oxidised successively rather than simultaneously.

Burma⁴⁶ showed that in most cases the R_f values of amino acids increased with increase in temperature even when solvents miscible with water like pyridine, acetone and iso-propyl alcohol were used, thereby showing that a change in the phase composition of the developing solvent was not the only cause for alteration of R_f values with temperature and that a decrease in the partition coefficient at higher temperatures might partly explain the increase in R_f values.

43. Burma, D. P. (1951), *J. Indian Chem. Soc.*, **28**, 631.

44. Rao, N. R., Shah, K. H and Venkataraman, K. (1950), *Current Science*, **19**, 142.

45. Roberts, E. A. H. and Wood, D. J. (1951), *Biochem. J.*, **49**, 414.

46. Burma, D. P. (1951), *Nature*, **168**, 565.

By employing the continuous development method of Miettinen and Viratnen and using 15% alcohol as the developing solvent, Burma⁴⁷ succeeded in separating the hydroxides of lithium, sodium and potassium.

Burma⁴⁸ studied the *Rf* values of amino acids on various grades of Whatman filter paper and concluded that Whatman No. 1, was decidedly the best suited for chromatography.

Burma and Banerjee⁴⁹ showed that in paper chromatography of amino acids the cellulose of the filter paper was not completely inert but played a part by weakly adsorbing the substances chromatographed.

Singh and Gupta⁵⁰ separated the cations Bi, Pb and Cu by using diethyldithiocarbanudohydroazine, as the complexing reagent for the cations in the form of a band I" behind the spot of cations and using acetone containing 5% HNO_3 as the developing solvent.

Mohan Rao⁵¹ studied the chromatographic behaviour of a few organic acids by using the horizontal migration technique of Rao and Beri⁵. They determined the *Rf* values in a number of developing solvents and showed that the circular *Rf* values varied only slightly from the straight *Rf* values.

Nayar and Mohan Rao⁵² chromatographed the cations of groups (1) and (2) by the ascending technique, using solvents like HCl , H_2SO_4 , HNO_3 , CH_3COOH , NH_4OH of 0.05 N strength as the developing solvents.

Giri and Nagabhushanam^{52(a)} successfully applied sodium 1:2 Naphthoquinone-4-sulfonate reagent for the identification of amino acids and estimation of proline and hydroxy proline by circular paper chromatography. These two amino acids gave an orange colour with the reagent which could be extracted with water and

47. Burma, D. P. (1952), *Analyst* **77**, 382.
48. Burma, D. P. (1952), *J. Indian Chem. Soc.*, **29**, 567.
49. Burma, D. P. and Banerjee, B. (1950), *Science and Culture*, **15**, 363.
50. Singh, M. M. and Gupta, J. (1951), *J. Sci. and Indust. Res., India*, **10B**, 289.
51. Mohan Rao, V. K. (1952), *Ibid.*, **11B**, 277.
52. Nayar, M. R. and Mohan Rao, V. K. (1952), *Ibid.*, **11B**, 78.
- 52(a) Giri, K. V. and Nagabhushanam, A. (1952), *Naturwissenschaften*, **39**, 548.

estimated colorimetrically. A linear relationship between the intensity of the color and concentration of amino acids in the range 10-100 μg . was obtained.

Miscellaneous

Biswas and Das⁵³ found the carotene content of several varieties of tomatoes by chromatographing petroleum ether or acetone extracts of the fruits on "magnesia-kieselguhr (50 : 50) columns. The carotenes were subsequently eluted and their content in the eluate determined by colorimetry. They found that the wilder varieties of tomatoes were richer in carotene content than the cultivated varieties.

Sen Gupta and Basu⁵⁴ separated arachis oil into two parts by chromatography on an alumina column using petroleum ether as the developing solvent.

Burma and Banerjee⁵⁵ prepared various grades of alumina from local sources for chromatographic work.

Singh⁵⁶ used successfully cellulose pulp obtained by treating absorbent cotton with dilute HNO_3 (5% V/V) as a substitute for pulp from Whatman tablets for chromatography.

53. Biswas, T. D. and Das, N. B. (1952), *Science and Culture* **18**, 91.

54. Sen Gupta, M. L. and Basu, U. P. (1952), *J. Indian Chem. Soc. Ind. and News Ed.*, **15**, 39.

55. Burma, D. P. and Banerjee, B. (1950), *Science and Culture*, **153**, 442.

56. Singh, M. M. (1951), *J. Sci. and Indust. Res. India*, **10A**, 249.

ENZYMES

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Contributions made during the year under review relate among others to the study of various esterases like lipases and phosphatases and to thiaminases and transaminases. Studies on enzyme inhibition in relation to drug action have also been reported.

Esterases:

Ramakrishnan and Nevgi^{1,2} reported further studies on the lipases from castor-seed. Optimum concentrations of di-sodium-phosphate-citric acid buffer and the enzyme for the synthesis (at pH 5.2) as well as hydrolysis (at pH 4.8) of amyl butyrate were described. Activity increased with the increase in the concentration of the enzyme. Using different volumes of the buffer solution in the reaction mixture — it has not been mentioned whether its volume was kept constant — 2 ml. of di-sodium-phosphate-citric acid buffer for synthesis and 3 ml. of buffer for hydrolysis were found to give the best results. Ramakrishnan and Banerjee³ studied the effect of the concentration of a wide variety of accelerators on the hydrolysis of fresh groundnut oil by castor-seed lipase (*Ricinus communis*) and found that the optimum concentration of the accelerator varied according to its nature. KH_2PO_4 (0.2 g.), N/10 acetic acid (4 ml.), and glycine (0.05 g.) were found to be the best accelerators. The optimum pH for the reaction varied from 4.6 to 4.8 depending on the nature of the accelerator.

Ramakrishnan and Banerjee⁴ continued their study of the lipases obtained from the molds grown on oilseeds. Molds grown on castor-seed were subcultured, pure strains prepared and dry preparations tested for lipolytic activity. *A. niger* C₁

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| 1. | Ramakrishnan, C. V. and Nevgi, G. V. (1952). <i>J. Indian Chem. Soc.</i> , | 29, 403. |
| 2. | <i>Idem.</i> (1952). <i>Ibid.</i> , 29, 405. | |
| 3. | Ramakrishnan, C. V. and Banerjee, B. N. (1952). <i>Ibid.</i> , 29, 400. | |
| 4. | <i>Idem.</i> (1952). <i>Ibid.</i> , 29, 397. | |

and *A. flavus* C₂ showed appreciable lipolytic action, the optimum pH being 6.2. These two strains as well as *A. oryzae* were grown in castor-cake medium and maximum lipolytic activity was observed when the medium contained 15% oil-free cake and 10% oil. A synthesis of 65.8% of butyl oleate was observed by the acetone-dried lipases from *A. niger* C₁ on the sixth day. Similar results were obtained by the same authors in their studies on lipases obtained from molds grown on *Sesamum indicum*⁵ and mustard-cake⁶ (*Brassica nigra*) media containing 10% of the corresponding oil.

Continuing his work on phosphatases, Sadasivan⁷ investigated the activity of the phosphatase in *Penicillium chrysogenum* Q-176 and found that the normal behaviour of the enzyme as an alkaline one was inhibited by cyanide and Ca⁺⁺ ions. Mg⁺⁺ ions were able to restore the cyanide-inhibited enzyme at neutral and acid ranges of pH as well as the Ca⁺⁺ ion inhibition. Zn⁺⁺ ions were able to restore the activity of the cyanide-inhibited enzyme at more alkaline pH ranges but not the Ca⁺⁺-inhibited enzyme. The concentration of Zn⁺⁺ appeared to influence the activity of the enzyme.

Krishnan⁸ found that fractionation of the extracts of the mycelial mat of *Penicillium chrysogenum* yielded an enzyme preparation capable of bringing about rapid dephosphorylation of adenosinetriphosphate, metaphosphate and pyrophosphate. At no stage of the fractionation there was a sharp break or differential concentration of the enzyme activity. They postulated that the same enzyme acted on the three different substrates, or the various enzymes (apyrase, metaphosphatase and pyrophosphatase) were so closely associated with one another as to be inseparable by fractionation. The pH of the reactions was

5. Ramakrishnan, C. V. and Banerjee, B. N. (1952), *Arch. Biochem. and Biophysics*, **37**, 131.

6. Ramakrishnan, C. V. and Banerjee, B. N. (1952), *Science and Culture*, **17**, 298.

7. Sadasivan, V. (1952), *Arch. Biochem. and Biophysics*, **37**, 172.

8. Krishnan, P. S. (1952), *Ibid.*, **37**, 224.

practically identical for the purified enzyme preparation as well as a ground suspension of the mat.

Thiaminases :

Deolalkar and Sohonie⁹ reported the presence of at least two or three enzymes with thiaminase activity and optimum pH at 3.6, 5.6 and 7.0 in the *Vaunshi* (*Mugil, Sp.*), a brackish-water variety of edible fish, quite popular in Bombay. Mn^{++} could restore the activity of the dialysed enzyme at pH 3.6 and 5.6 but not at pH 7.0. Liver and spleen of the fish were good sources of the enzyme. An important role in the metabolic processes of the fish was attributed to the enzyme in view of its wide distribution in tissues and organs of the fish. Chitre and Kelkar¹⁰ found that the thiaminase from Bombay duck (*Horpedon nehucus*) when added to a co-carboxylase-pyruvate system at the start of the experiment and after a lapse of 1½ hrs. gave different types of curves for the progressive output of CO_2 in a Warburg respirometer. This was ascribed to the influence of the products of pyruvate degradation. Addition of micro-amounts of acetaldehyde to the system produced the same type of effect as the delayed addition of thiaminase. Acetaldehyde is supposed to be the inhibitor of the thiaminase from Bombay duck.

Transaminases :

Bheemeswar and Sreenivasaya¹¹ reported the occurrence of transaminase in the silkworm, *Bombyx mori L.* The extracts of haemolymph and the silk gland and intestine of the insect which constitute sites of intense protein metabolism contained a transaminase capable of mediating the transfer of the amino group of aspartic acid to α -ketoglutaric acid. This study was made using the strip method of paper chromatography. In addition to a glutamic acid spot, another spot with an Rf value 0.42 was found in the experiments with the glandular and intestinal extracts of the silkworm and also with the extract of the heart muscle of the rat. It is claimed to be a peptide—being the product of transpeptidation.

9. Deolalkar, S. T. and Sohonie, K. (1952), Current Science, **21**, 13.

10. Chitre, R. G. and Kelkar, S. (1952), *Ibid.*, **21**, 219.

11. Bheemeswar, B. and Sreenivasaya, M. (1952), *Ibid.*, **21**, 253.

The haemolymph of the silkworm showed a comparatively low transaminase activity compared to that of the glandular and intestinal extracts.

Giri *et al*^{12,13}, have described a simple circular paper chromatographic method for determining the transaminase activity in plant tissues.

Other Enzymes:

Sri Ram and Giri¹⁴ found that green gram contained a phosphorylase and another enzyme capable of converting amylose into amylopectin thus resembling the Q-enzyme of potato. Methods for the isolation and some properties of the enzymes have been described. The mechanism of starch synthesis in green gram is supposed to be the same as in potatoes.

Vibrio cholera was shown to possess deaminases in its enzyme make-up¹⁵ and the rate of deamination varied with the amino-acid and the strain. Aspartic acid and serine showed maximum deamination. Ogawa sub-types showed higher deaminase activity than the Inabas. Deamination was aerobic and the optimum pH of the reaction was in the range 7-8. Narayanan and Menon¹⁶ found that a collagenase was present in culture filtrates of *V. cholerae* with an optimum pH at 8.0.

By a study of the iodine absorption of pepsin and trypsin at different pH, Basu and Nandi¹⁷ reported that the pH optima were associated with maximum compactness of the coiled-up structure of the protein molecule.

12. Giri, K. V., Radhakrishnan, A. N. and Vaidyanathan, C. S. (1952), *Nature*, **170**, 1025.

13. Giri, K. V., Radhakrishnan, A. N. and Vaidyanathan, C. S. (1952) *J. Indian Inst. Science*, **34**, 305.

14. Sri Ram, J. and Giri, K. V. (1952), *Arch. Biochem. and Biophysics*, **38**, 231.

15. Dudani, A., Iyer, S. N., Krishnamurti, C. R. and Shrivatsava, D. T. (1952), *Current Science*, **21**, 134.

16. Narayanan, E. K. and Menon, P. S. (1952), *Nature*, **170**, 621.

17. Basu, S. and Nandi, S. P. (1952), *Nature*, **169**, 799.

Enzyme Kinetics and Inhibition :

Gaitonde and Sohoni¹⁸ reported the presence of a trypsin inhibitor in the seeds of *Dolichos lab lab*, *Vigna catieng*, *Cicer arietinum*, and *Phaseolus mungo*. Green gram contained none. *Dolichos lab lab* was a rich source of the inhibitor. Germination of the pulses normally reduced the degree of inhibition. The trypsin inhibitor of field bean (*Dolichos lab lab*) could be extracted with water, 5% NaCl or dilute HCl and had no effect on pepsin activity. The activity of the inhibitor was lost on autoclaving for 20 minutes at 20 lbs. pressure. The inhibitor was non-dialysable and was completely precipitated from the seed extract by half-saturation with ammonium sulphate.

Urease activity was inhibited by vitamin C and more markedly by vitamin C-copper complex according to Rao and Giri¹⁹, who suggested the possible formation of intermediate products like Cu₂O or the oxidation of the vitamin as being responsible for the inhibition.

Viswanatha and Rajagopalan²⁰ made a study of the mechanism of action of the soyabean inhibitors. Release of amino-nitrogen and the level of toluene in a three-bulbed dilatometer indicated a fall and rise as a result of the action of the inhibitors, both the phenomena were smooth. On the basis of these observations, the authors suggested that the inhibitor was responsible for disaggregation of the colloidal protein and aggregation of the breakdown products and that the inhibitor acted as an antipeptidase of trypsin when the tryptic digestion had proceeded to a certain extent.

Certain antibiotics like penicillin, dihydrostreptomycin, aureomycin and chloromycetin were shown²¹ to enhance the casein-hydrolysing activity and inhibit the milk-clotting activity of papain. For casein-hydrolysis the activity of the antibiotics was

18. Gaitonde, M. K. and Sohoni, K. (1952). Jour. Sci. and Indust. Res. India, **11B**, 339.

19. Rao, P. S. and Giri, K. V. (1952). Proc. Indian Acad. Science, **35B**, 132.

20. Viswanatha, T. and Rajagopalan, R. (1952). Current Science, **21**, 104.

21. Rao, V. K. M., Krishnamurti, C. R. and Shrivatsava, D. L. (1952). J. Sci. and Indust. Res. India, **11B**, 299.

highest at a pH 4.0. Aqueous medium was found to be better than buffered medium for the inhibition of milk-clotting activity. Reactivation of the inhibited-papain could be achieved by H_2S or by glutathione, indicating that thiol groups of the enzyme protein was involved in the inhibition. Chloromycetin-inhibited bacterial amylases could be partially restored by tyrosine according to Arora and Krishnamurti²², lending support to the assumption that tyrosine groups were also essential for amylolytic activity. Activation of malt and fungal amylases by dihydrostreptomycin and aureomycin observed by the same authors was ascribed to the stabilization of the enzyme against the inactivating influence of the alkaline medium. None of these antibiotics had any significant effect on pancreatic amylase. Studies carried out on urease by Agarwala *et al*²³ indicated that allicin, chlormycetin, aureomycin, streptomycin and sulphanilamide inhibited urease activity, the optimum pH of inhibition being 7.8. H_2S or glutathione reactivated the inhibited enzyme. Penicillin, sulphathiazole and sulphaguanidine exerted an activating action on urease.

Quinine was found to suppress the activity of succinic dehydrogenase²⁴ better than paludrine or a pyrimidine antimalarial. A triazine derivative to which the antimalarial action of paludrine was ascribed, was without effect on the activity of the succinic dehydrogenase.

Ramakrishnan *et al*²⁵ reported the occurrence of a blood-anticoagulant factor in the latex of *carica papaya*. The acetone-dried powder of papaya latex was extracted with water and fractionated with ammonium sulphate into two factors one of which was found to accelerate and the other to inhibit the clotting of blood. The inhibitor was precipitated at 0.5 saturation. The anticoagulant was thermolabile and lost its activity on long standing in aqueous solution.

Investigations on the chromatography of enzymes have been reviewed in another section.

22. Arora, K. L. and Krishnamurthi, C. R. (1952). *J. Sci. and Indust. Res., India*, **11B**, 383.

23. Agarwala, S. C., Krishnamurti, C. R. and Shrivatsava, D. L. (1952). *Ibid.*, **11B**, 165.

24. Datta, A. G. and Basu, U. P. (1952). *Ibid.*, **11B**, 431.

25. Ramakrishnan, T., Pillai, N. C. and Giri, K. V. (1952). *Current Science*, **21**, 251.

GENERAL MICROBIOLOGY INCLUDING ANTIBIOTICS

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This review covers the research work published during 1952. Interest in microbiology and especially in antibiotics from plant sources continued to be unabated. The innumerable medicinal and other plants available in India have proved a fertile source of raw material for investigators in this field. The subject has been summarised under the following sections: (i) General and metabolic studies, (ii) Applied microbiology and industrial fermentation, (iii) Immunochemical studies and (iv) Antibiotics. Work on soil microbiology and dairy microbiology are omitted from this review, as these subjects are likely to be fully covered in other chapters dealing with soils and fertilizers and with dairy science. A new section on immunochemical studies has been added as a few workers have shown an interest in this subject and some papers also have appeared. It is expected that this subject will receive increasing attention in future years.

I. General and Metabolic Studies

General Microbiology :

Iyer and Bhat¹ studied the resistance of *B. megatherium*, *B. cereus* and *B. subtilis* to sodium benzoate and sodium metabisulphite. They found that the two preservatives in permissible concentrations were efficacious only at pH 5 but not at pH 6. They also studied the resistance of these organisms to heat². The thermal resistance of the spores of these bacilli was high; *B. subtilis* spores survived even after exposure for 1 hour at 120°C.

Morphological, cultural and physiological characters of strains of *Nocardia corallina* and *Nocardia rubra* isolated from coconut oil and the alimentary canal of the earthworm were studied by

1. Iyer, V. and Bhat, J. V. (1952), J. Sci. and Indust. Res., India, 11B, 480.

2. *Idem,*

(1952),

Ibid. 11B, 427.

Vakil, Khambata and Bhat.³ When grown on Ashby's nitrogen free medium *N. corallina* showed bipolar granules while *N. rubra* showed subcentrally situated granules.

Mukherji⁴ working on the effect of irradiation on the staining properties of gram negative bacteria reported that *B. coli*, *E. typhi* and *Sh. dysenterie* were rendered gram positive after 1 or 2 hours irradiation with ultra violet rays. However if they were first exposed to infra red rays for 2 hours, they did not become gram positive after further irradiation with ultra violet rays. Gram negative bacteria previously irradiated with ultra violet rays for 2 hours remained gram negative after further irradiation with infra red rays. Gram positive bacteria such as *Strep. haemolyticus* and *Staph. aureus* were rendered gram negative and doubtful gram, respectively, after one to two hours exposure to infra red rays.

Ranjan, Nigam and Shukla⁵ studied the atmospheric fungal flora of Kanpur City. They found general agreement between the occurrence of cellulose destroying fungi in the atmosphere and those encountered in deteriorated cotton stores.

The use of mycobacterium carotinogen for the assay of liver extracts was tried by Pradhan.⁶ The method was of doubtful value as the growth period for assay was 21 days.

Studies on Enzymes of Microbes :

Sadasivan⁷ continued his studies on the phosphatase of *Penicillium chrysogenum* Q-176. Krishnan⁸ studied what he believed to be a different phosphatase of *Penicillium chrysogenum*.

The degradation of butyric acid by *Aspergillus niger* was studied by Mukherji.^{9,10} Results suggested that the degradation

3. Vakil, J. R., Khambata, S. R. and Bhat, J. V. (1952), Proc. Indian Acad. Science, **36B**, 243.

4. Mukherji, A. (1952), Indian J. Med. Res., **40**, 167.

5. Ranjan, B. S. V. Nigam, S. S. and Shukla, R. K. (1952), Proc. Indian Acad. Science, **35B**, 33.

6. Pradhan, V. G. (1952), Indian J. Pharm., **14**, 171.

7. Sadasivan, V. (1952), Arch. Biochem. and Biophysics, **37**, 172.

8. Krishnan, P. S. (1952), *Ibid.*, **37**, 224.

9. Mukherji, S. (1952), *Ibid.*, **35**, 23.

10. *Idem*, (1952), *Ibid.*, **35**, 34.

took place according to β -oxidation theory as well as according to dehydrogenation mechanism. The presence of acetoacetic acid in the oxidation products was taken as proof in support of former hypothesis and the development of slight unsaturation as indicative of the latter.

Ramakrishnan and Banerjee^{11,12} investigated lipolytic activity of moulds grown on *sesamum indicum* and on groundnut cake. Using the mould lipases they were able to synthesise n-butyl oleate.

Damodaran and Rangachari¹³ studied the effect of inhibitors for glycolysis and respiration on citric acid formation by *A. niger*. Cyanide had little effect on acid formation but M/1000 iodoacetate or M/300 fluoride acted as inhibitors, suggesting that anaerobic processes were involved. Azide which inhibited in a concentration of M/5000 was presumed to act by its effect on oxidative phosphorylation.

Siva Sankar, Tirunarayanan and Sarma¹⁴ investigated the role of biotin in the nutrition and metabolism of a cholineless mutant of *Neurospora crassa*. It was found that sodium or potassium oleate could replace biotin in the nutrition of the mould more efficiently than soaps of saturated acids like palmitic or stearic acids. Biotin was found to stimulate the assimilation of nitrogen and the production of fat in the mould.

Production and studies of mutant strains:

Gattani¹⁵ was able to produce white non-sporing mutant strains of *Penicillium notatum* by radioactivity. The technique was very simple. The mould was first grown on potato dextrose agar containing 0.5 to 1.0 g. of uranium nitrate per litre. When growth commenced, the actively growing mycelium were transferred to media containing 0.5, 1.0, 1.5 and 2.0 g. of uranium nitrate

11. Ramakrishnan, C. V., and Banerjee, B. N. (1952), Arch. Biochem. and Biophysics, **37**, 131.

12. *Idem*, (1952), Biochem. et Biophys. Acta., **8**, 216.

13. Damodaran, M. and Rangachari, P. N. (1952), Enzymologia, **15**, 83.

14. Siva Sankar, D. V., Tirunarayanan, M. D. and Sarma, P. S. (1952), J. Sci. and Indust. Res., India, **11B**, 63.

15. Gattani, M. L. (1952), Current Science, **21**, 167.

per litre. Mutant strains were recognised by the production of morphologically distinct sectors in the growing colonies. More than 50 primary mutants were obtained from one strain (No. 18) of *Penicillium notatum chrysogenum*. During subculturing, about 20 reverted to parent strain and were discarded. Sixteen mutants showed green sporing areas and 14 were white and mycelial in character. The mycelial non-sporing mutants however produced less penicillin than their parent. Later, Gattani¹⁶ was able to produce other mutant strains using the same technique which did produce higher amounts of penicillin than the parent strains 18 and Minnesota X1612, both of which were already known to be high penicillin producers.

Subramaniam and Sreepathi Rao¹⁷ studied the mutagenic effect of camphor on fermenting yeast cultures. Tubes containing 1, 2, 3, 4 or 5 drops of a known concentration of camphor in alcoholic solution was added to 5 ml. of wort and inoculated with a few cells of aerobically growing cultures of a diploid strain. 24, 48, 72 and 168 hours later giant colony inoculations were carried out. The character of the giant colonies indicated that camphor had induced gene mutations resulting in stable tetraploids. In the next paper on the same subject, Duraiswami and Subramaniam¹⁸ reported that irradiation of a diploid brewery yeast strain with ultra violet light resulted in formation of tetraploids. From the nature of giant colony it was surmised that ultra violet irradiation had both immediate as well as delayed effects.

The fermentation characteristics of a diploid brewery yeast and its autotetraploid were compared by Mitra¹⁹. The tetraploid strain showed faster growth rate and 30% better efficiency in fermentation than the diploid strain. There was

16. Gattani, M. L. (1952), *Science*, **116**, 596.

17. Subramaniam, M.K. and Sreepathi Rao, S. K. (1952), *Proc. Indian. Acad. Sci.*, **35B**, 1.

18. Duraiswami, S. and Subramaniam, M.K. (1952), *Ibid*, **35B**, 155.

19. Mitra, K. K. (1952), *Biochem. et Biophys. Acta.*, **8**, 615.

however no difference in the sugar tolerance between the two strains.

II. Applied Microbiology and Industrial Fermentation

Shukla and Seth²⁰ determined the conditions for the high metabolic activity of yeast (I. I. S. T. No. 3) in batch fermentation of molasses. The effect of addition of ammonium sulphate, peptone, and yeast autolysate to media containing glucose, clarified molasses or unclarified molasses were investigated. The highest metabolic activity was attained when yeast extract was added as supplement to medium containing clarified molasses. The activity of yeast was higher at 10% sugar than at 16 or 22% and the maximum activity was also attained earlier.

Jhaveri and Joshi²¹ determined the effect of aeration at different incubation times and substitution of oil cake for peptone, on the growth of yeast. Yields were better with increased aeration and increase of incubation time from 2 to 3 days. Substitution of oil cake for peptone gave less yield.

The influence of some environmental factors on the growth and riboflavin production in a riboflavin excreting yeast (BY 2) was studied by Mitra.²² Biotin was the only vitamin essential for growth and production of riboflavin. A synthetic medium containing glucose 4%, Difco yeast extract 0.04% and salts gave good growth and a yield of 65.2% μ g. of riboflavin per ml. of culture medium after 7 days incubation. The growth and production capacity of the organism increased upto a limit with increase in the surface area per unit volume of the culture medium.

Lulla²³ studied the cultural conditions for the production of amylase by *B. subtilis*. 8 mg. of ammonium nitrate and 400 mg. of starch per 10 ml. of culture medium gave the highest yield of the enzyme. The optimum concentration of various salts for production of amylase has been determined. In another paper

20. Shukla, J. P. and Seth, S. P. (1952), *J. Sci. and Indust. Res. India*, **11B**, 10.
21. Jhaveri, J. D. and Joshi, N. V. (1952), *Indian J. Pharmacy*, **14**, 128.
22. Mitra, K. K. (1952), *J. Sci. and Indust. Res. India*, **11B**, 109.
23. Lulla, B. S. (1951), *Biochem. et Biophys. Acta*, **7**, 244.

Lulla²⁴ studied the amino acid requirements of *B. subtilis* (N. C. Tc. 2027N) for amylase formation. Arginine, histidine and alanine gave best results.

An Indian Patent No. 43542 has been granted to the Council of Scientific and Industrial Research²⁵ for improvements in fermentation processes which consisted in passing molasses through a column packed with pumice impregnated with yeast.

III. Immunochemical Studies.

Seal²⁶ isolated an active polysaccharide fraction from the supernatant of the Haffkine plague vaccine. The active polysaccharide was hydrolyzed and a crystalline osazone resembling that of arabinose with a melting point of 166°-168°C was prepared. The osazone could also be prepared from the specific soluble proteins of the plague organisms of both virulent and avirulent protective plague strains but not from nonprotective avirulent plague and pseudotuberculosis organisms. The protective substance of plague bacillus was considered by him to be a polysaccharide-protein complex. In a second paper Seal²⁷ fractionated the specific soluble proteins of virulent and avirulent protective plague strains and pseudotuberculosis bacilli, all grown in casein hydrolysate broth at 28°C for 24 hours. The fractionations were carried out with sodium sulphate. Fraction A, insoluble in 1/3 saturation, fraction B, between 1/3 to 1/2 saturation and fraction C, between 1/2 to full saturation were prepared. Fraction A, insoluble in 1/3 saturation contained the specific antigen of virulent plague bacillus corresponding to the envelop antigen of Schutze. Fraction B probably acted as a common somatic link between plague and pseudotuberculosis organisms. Antiserum against A, agglutinated plague strains but not pseudotuberculosis organisms.

24. Lulla, B. S. (1952), *Science and Culture*, **17**, 385.

25. Council of Scientific and Industrial Research. Indian Patent No. 43542 (J. Sci. and Indust. Res. India, 1952, **11A**, 275.)

26. Seal, S. C. (1951), *Proc. Soc. Exp. Biol. and Med.*, **77**, 675.

27. *Idem.* (1951), *J. Immunol.*, **67**, 93.

Lahiri²⁸⁻³⁰ worked on the detection and isolation of natural non-specific synergists which enhance the immunogenicity of diphtheria toxoid. Such a synergist was found in the diphtheria cultures grown on veal infusion proteose peptone broth but not in pig stomach autolysate or casein hydrolysate liver extract. Further work showed that the synergist in veal infusion proteose peptone broth culture filtrate was in the dialysable impurities. From the dialysate it could be purified by concentration under low pressure, adsorption on activated charcoal and elution of the charcoal with 0.01 N NaOH. The purified synergist enhanced the immunogenicity of only diphtheria toxoid and not tetanus toxoid. Its immunogenicity was more than that of an equal quantity of alum.

Narayanan and Menon³¹ found the presence of a collagenase in vibrio cholera culture filtrates. Dudani, Iyer, Krishna Murthi and Shrivatsava³² tried to correlate the pathogenicity and interrelationships, if any, among the various strains of cholera by measuring their deaminase activity. It was observed that in general, the Ogawa subtypes showed higher deaminase activity than the Inabas. It was also found that Inaba subtypes obtained from Ogawa had less deaminase activity than the parent Ogawa strains.

Rao, Ramaswamy and De³³ attempted immunological study of avian malaria (*P. gallinaceum*) by the anaphylactic reaction. Hemoglobin-free erythrocyte protein of chick and of malarial parasite proteins were prepared. By Schultz-Dale technique the two were found to be antigenically similar. This probably explains the low levels of immunity in malaria infection.

- 28. Lahiri, D.C. (1951), Indian J. Med. Res., **39**, 229.
- 29. *Idem*, (1952), *Ibid.*, **40**, 109.
- 30. *Idem*, (1952), *Ibid.*, **40**, 265.
- 31. Narayanan, E. K. and Menon, P. S. (1952), *Nature*, **170**, 621.
- 32. Dudani, A. Iyer, S.N., Krishna Murthi, C. R. and Shrivatsava, D.L. (1952), *Current Science*, **21**, 134.
- 33. Rao, R. R., Ramaswamy, A. S. and De, N. N. (1951), *Proc. Indian Acad. Sci.*, **34B**, 242.

IV. Antibiotics

Antibiotics from plant sources :—

Suri³⁴ found that an aqueous extract of fresh raw garlic (*Allium sativum*) inhibited the growth of tubercle bacillus strain H52 in modified Proskauer and Beck's medium containing 10% horse serum. However, *in vivo* studies in guinea-pigs injected intraperitoneally with tubercle bacilli strain H37R, the oral feeding of fresh raw garlic did not prevent or delay the onset of the disease.

Rao and Verma³⁵ attempted to study the structure of allicin the antibiotic principle of garlic.

A most interesting report was by Gangadharam, Narayana-murthy and Iyer.³⁶ They found that sesamin, one of the crystalline constituents of the unsaponifiable fraction of sesame oil, showed *in vitro* activity in a dilution of 1: 1000, 000 against *Mycobacterium tuberculosis* (H37Ri) when tested on Youman's synthetic liquid medium. It had no activity against common pathogens like *Staph. aureus*, *Strep. pyogens*, *B. coli* and *B. typhosus*. Results of *in vivo* studies are awaited.

Rao and Verma³⁷ found that Morellin, the antibiotic from *Garcina morella*, could be administered in 2 to 4% solution subcutaneously upto 450 mg. per kilo of body weight of mice without ill-effects. For topical application in septic wounds due to pathogenic cocci, they recommended 2% olive oil solution or 1% lanolin ointment. They³⁸ also investigated some colour reactions for morellin.

The purification of the antibiotic from *Moringae pterygosperma* was attempted by Kurup and Rao.³⁹

34. Suri, J. C. (1951). Indian J. Med. Res., **39**, 411.

35. Rao, P. L. N., and Verma, S. C. L. (1952). J. Indian Inst. Science, **34A**, 315.

36. Gangadharam, P. R. J., Narayananmurthy, N. L. and Iyer, B. H. (1952). Current Science, **21**, 246.

37. Rao, P. L. N. and Verma, S. C. L. (1952). *Ibid.*, **21**, 219.

38. *Idem*, (1952), J. Sci. and Indust. Res., India, **11B**, 206.

39. Kurup, P. A. and Rao, P. L. N. (1952). J. Indian Inst. Science, **34A**, 219.

Sirsi, Natarajan and Nayak⁴⁰ studied the antimicrobial activity and pharmacological properties of some essential oils extracted from locally cultivated plants.

Joshi and Magar⁴¹ reported on the antibiotic activity of extracts of 63 medicinal plants against *Staph. aureus* and *E. coli*. Bhat and co-workers⁴² found an antibiotic principle in the fruit of *Thespesia populnea* effective against gram positive and gram negative bacteria. Mehta and Bhat⁴³ reported a new antibacterial substance in the leaves of *Bryophyllum calycinum* which was active against a wide range of both gram positive and gram negative bacteria.

Broker and Bhat⁴⁴ evaluated the phagocytic coefficients of water extracts of leaves of *Murraya koenigi* spreng and nuts of *Areca catechew*. The former had a favourable influence on phagocytic action and the latter an unfavourable influence.

Antibiotics from fungal sources :

Rangaswami and Subramanian⁴⁵ reviewed the work done in foreign countries on the antibiotic activity of lichens and pleaded for their investigation in India.

The antibiotic activity of some higher fungi was tested by Bose.⁴⁶ The most promising was *Psalliota cumpestris* the common edible mushroom.

Vasudeva, Jain and Nema⁴⁷ found that *B. subtilis* produced an antibiotic against *Fusarium udum* Bull, the fungus

40. Sirsi, M. Kale, L., Natarajan, S. and Nayak, V. B. (1952), J. Indian Inst. Science, **34A**, 261.

41. Joshi, C. G. and Magar, N. G. (1952), J. Sci. and Indust. Res. India, **11B**, 261.

42. Bhat, J. V., Mehta, S. and George, M. (1952), J. Univ. Bombay, **21**, (New Series Part 3), 15.

43. Mehta, S. and Bhat J. V. (1952), *Ibid.*, **21**, (New Series Part 3), 21

44. Broker, R. and Bhat, J. V. (1952), Current Science, **21**, 43.

45. Rangaswami, S. and Subramanian. S. S. (1952), Indian J. Pharm., **14**, 214.

46. Bose, S. R. (1952), J. Sci. and Indust. Res. India, **11B**, 159.

47. Vasudeva, R. S., Jain, A. C. and Nema, K. G. (1952), Ann. Appl. Biol., **89**, 229.

causing wilt of pigeon-pea (*Cajanus cajan*). Suitable culture media for production of the antibiotic has been described.

Bhide, Moniz and Patil⁴⁸ tested actinomyces isolated from Karnatak soil to see whether they produced antibiotic to plant pathogenic bacteria. Of 64 cultures, only seven proved antibiotic to 3 or more species of *Xanthomonas*.

Studies in synergism among Antibiotics :—

Sirsi and Kale⁴⁹ studied the *in vitro* synergistic action of aureomycin and para amino salicylic acid against some pathogenic bacteria. The minimum inhibitory concentration was reduced 2 fold of PAS and 100 fold of aureomycin when the two were used together against all organisms tested except *S. typhosa*.

De and Das⁵⁰ found that chloramphenicol and terramycin had slightly stronger inhibitory effect on *S. typhosa* than when used alone. The synergism was not so evident when the two drugs were tried in 11 cases of typhoid fever.

Chopra and Gupta^{51,52} found *in vitro* that gram negative organisms resistant to penicillin became highly susceptible when a combination of penicillin and streptomycin, or penicillin and chloromycetin was used. They also observed an *in vitro* synergism when streptomycin and chloromycetin were tested against *M. tuberculosis*⁵³.

Mode of Action of Antibiotics :

With a view to elucidating the mechanism of action of antibacterial agents, inhibition studies on isolated enzyme systems were made by workers at the Central Drug Research Laboratory. In the first paper⁵⁴ they reported that allicin (1), chloromycetin (2), aureomycin (3), streptomycin (4), and sulphanilamide (5), inhibited urease at pH 7.8, while penicillin (6),

48. Bhide, V.P., Moniz, L. and Patil, R.S. (1952). *Current Science*, **21**, 70.

49. Sirsi, M. and Kale, L. S. (1951). *Indian J. Med. Res.*, **39**, 397.

50. De, S. P. and Das, A. (1952). *Calcutta Med. J.*, **49**, 73.

51. Chopra, I.C. and Gupta, K. C. (1951). *Indian J. Med. Res.*, **39**, 507.

52. *Idem*, (1951), *Ibid.*, **39**, 517.

53. *Idem*, (1951), *Ibid.*, **39**, 523.

54. Agrawala, S. C., Krishna Murthy, C. R. and Shrivatsava, D. L. (1952). *J. Sci. and Indust. Res. India*, **11B**, 165.

sulphathiazole, (7) and sulphaguanidine (8) exerted an activating action on urease. In their second paper⁵⁵ they reported that (2), (3), (4), and (6) reversibly inhibited the milk clotting activity of papain. In their third paper⁵⁶ they reported that (3) and (4) accelerated activity of malt and fungal amylase, but (3) partially inhibited bacterial amylase.

General Studies

Arora and Krishna Murti⁵⁷ developed a colour reaction for chloromycetin. The colour produced when alkaline picric acid or dinitrosalicylic acid and Rochelle salt were added to chloromycetin was measured with a green filter at 530 m μ .

Dudani and Agarwala⁵⁸ described a medium for the assay of antibiotics which could be prepared from indigenous material. The medium consisted of acid digest of casein, papain digest of meat, yeast extract and glucose.

55. Mohan Rao, V. K., Krishna Murti, C. R. and Shrivatsava, D. L. (1952), *J. Sci. and Indust. Res. India*, **11B**, 299.

56. Arora, K. L. and Krishna Murthi, C. R. (1952), *Ibid.*, **11B**, 383.

57. Arora, K. L. and Krishna Murthi, C. R. (1952), *Current Science*, **21**, 52.

58. Dudani, A. T. and Agarwala, S. C. (1952), *J. Sci. and Indust. Res. India*, **11B**, 551.

VITAMINS

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The bulk of work relating to vitamins is mainly on problems relating to vitamin A, folic acid and vitamin B₁₂. Next comes the work on biosynthesis of nicotinic acid and ascorbic acid. Notable contributions have been made by some young Indian scientists working in collaboration with some of the leading workers in the U. S. A. and England.

Carotene and Vitamin A :

De and Sundararajan¹ investigated the site of *in vivo* conversion of carotene to vitamin A in the albino rat. They fed β -carotene in sesame oil in amounts of 500 μ g. in single doses and the fate of carotene in the small intestine was followed. There was no change in carotene in the intestinal lumen while the intestinal wall contained small amounts of carotene and vitamin A. When an excised loop of intestine containing β -carotene was incubated in tyrode solution, there was no success in an attempt to demonstrate the *in vitro* conversion of β -carotene to vitamin A in the intestine. Esh and Bhattacharya² studied the effect of feeding massive doses of vitamin A acetate to rats on liver storage. Groups of rats deficient in vitamin A were given in three days 1800 I. U. of vitamin A alcohol or acetate diluted in arachis oil, ethyl oleate or water containing a dispersing agent. The animals were then killed and the vitamin A content in liver analysed. A wide variation was noticeable. With the acetate, storage of 630 I. U., 500 I. U. and 710 I. U. were noticed. For the alcohol the values were 581, 446 and 308 I. U. according to whether the vehicle was aqueous, ethyl oleate or arachis oil. The female rats showed higher storage than the males in all the groups.

1. De, N. K. and Sundararajan, A. R. (1951), Indian J. Med. Res., 39, 479.

2. Esh, G. C. and Bhattacharya, S. (1951), Indian J. Physiol. & Allied Sci., 5, 15.

Lahiri³ drew attention to the importance of giving large doses of vitamin A to children suffering from various skin diseases. He in collaboration with Scandrett⁴ described a method of estimating carotene and vitamin A in 2.0 ml. serum. They used activated glycerol dichlorhydrin as the reagent instead of $SbCl_3$ and found that the colour was more stable and followed Beers' law over a wide range. Sixty minute incubation at 50°C with 2.0 ml. N alcoholic potash per 2.0 ml. serum was recommended for saponification. The mean values found for vitamin A were 187 I. U. with a range of 72 to 301 per 100 ml. serum, and for carotene 68 I. U. with a range of 21 to 153. The values in general were higher for men than for women. Ramalingaswami and Sinclair⁵ drew attention to the follicular hyperkeratotic condition in the rats and its association with vitamin A and essential fatty acid deficiencies.

Bhatia⁶ investigated the effect of Indian cooking processes on the stability of vitamin A. The destruction of the vitamin amounted to 20-100%. Frying for more than 15 minutes resulted in total loss of vitamin A, largely due to oxidative destruction. On the other hand, methods of cooking involving wet treatment resulted in increased retention of the vitamin.

Biswas and Das⁷ analysed the colouring pigments of tomato. Carotene was separated from lycopene by chromatography using a mixture of Kieselguhr and activated magnesia. The carotene contents were found to vary from 2.2 to 15.7 p.p.m. in different varieties of tomato. In the same variety, the ripe fruit appeared to have higher content of carotene than the less ripe ones. Natarajan and MacKinney⁸ studied the carotenoid pigments of Valencia orange juice. The majority of the components showed absorption spectra maxima at wave lengths shorter than those at

3. Lahiri, K. D. (1951), Indian J. Paediat., **18**, 125.

4. Lahiri, K. D. and Scandrett, F. J. (1952), Edinburgh Med. J., **59**, 39.

5. Ramalingaswami, V. and Sinclair, H. M. (1951), Brit. J. Nutr., **5**, XI.

6. Bhatia, I. S. (1952), Bull. Central Food Tech. Res. Inst., **2**, 72.

7. Biswas, T. D. and Das, N. B. (1952), Science and Culture, **18**, 92.

8. Natarajan, C. P. and MacKinney, G. (1952), J. Sci. and Indust. Res., India, **11B**, 416.

which the absorption maxima of α and β carotene occur. They found that two components had the absorption maxima similar to those of lutein epoxide and flavoxanthin. The pigment with absorption maxima intermediate between phytofluene and S-carotene appeared to be a new one. Goodwin and Malini Jamikorn⁹ carried out experiments on the biosynthesis of carotenes in ripening tomatoes. They showed that the major route of α and β -carotene synthesis was entirely separate from the mechanism producing the Porter-Lincoln series (Arch. Biochem. 1951, **27**, 390). Only about 15% could be accounted for by this way. An assumption was put forward that the synthesis was due to a "carry-over" of the mechanism operating in green leaves and gave reasons in support of this.

Cama, Dalvi, Morton, Salah, Steinberg and Stubbs¹⁰ estimated the vitamin A₁ and vitamin A₂ contents of several varieties of fish. The Ling Cod (*Ophiodon elongatus*) had vitamin A₂ to A₁ in the proportion 1/8-1/10. The partially sterol-free unsaponifiable fraction in light petroleum, left to stand on manganese dioxide, gave a mixture of retinene₁ and retinene₂ which could be separated by chromatography. The liver oil of Pike (*Esox lucius*) gave more vitamin A₂ than A₁ and the unsaponifiable fraction after oxidation gave a mixture of the two retinenes which could be similarly separated. Liver oil from mixed large fresh water fishes of lake Nyasa contained upto 15% of the mixed vitamins (A₂/A₁ about $\frac{1}{3}$) and the sterol free unsaponifiable matter on oxidation gave retinenes. It was shown that retinene₂ is an aldehyde, C₂₀H₂₆O, forming a 2:4-dinitro phenylhydrazone and semicarbazone. The absorption curves were max. 386 m μ in cyclohexane E% 1440; and SbCl₃ test greenish blue, max. 740 m μ initially, fading to 705 m μ . Cama, Dalvi, Morton and Salah¹¹ studied the properties of retinene₂ and found that with aliphatic amines it formed spectroscopic analogues of acid and alkaline indicator yellow₂.

9. Goodwin, T. W. and Jamikorn, M. (1952), Nature, **170**, 104.

10. Cama, H. R., Dalvi, P. D., Morton, R. A., Salah, M. K., Steinberg, G. R. and Stubbs, R. (1952), Biochem. J., **52**, 542.

11. Cama, H. R., Dalvi, P. D., Morton, R. A. and Salah, M. K. (1952), *Ibid.*, **52**, 540, 542.

With aromatic amines, compounds were formed which after acidification gave a new broad band with λ max. 560 m μ . With concentrated sulphuric acid coloured unstable compounds showing absorption maxima at 570, 525 and 470 m μ , were obtained. The same workers observed that retinene₂ when fed to rats was converted to vitamin A₂ which could be found in the liver in 24 hours after feeding. They stated that vitamin A₂ was not so well stored as vitamin A₁. On reduction of retinene₂ they obtained vitamin A₂. The SbCl₃ reaction of vitamin A₂ was studied. They are of the opinion that vitamin A₂ is 3-dehydro vitamin A₁. Cama, Field, Glover, Morton and Salah¹² studied the Oppenauer oxidation of vitamin A. They used diethyl ketone as hydrogen acceptor. From the complex mixture obtained, a compound C₂₀H₂₆O, isomeric with retinene₂, was isolated. This compound was reducible *in vitro* and *in vivo* but the product was distinct from vitamin A₂. Vitamin A acetate was not dehydrogenated directly to vitamin A₂.

Chanda,¹³ and Chanda¹⁴⁻¹⁷ and associates published several papers during the year on carotene and vitamin A distribution in cow and goat milk and the effect of thyroid hormone on them.

Ganguly, Krinsky, Mehl and Deuel (Jr.)¹⁸ studied the distribution of vitamin A and carotenoids in fractions of plasma protein. They found that in chicken, vitamin A ester was found to be associated with the least soluble and vitamin A alcohol and lutein with the more soluble fractions. In beef plasma, β -carotene, lutein and vitamin A alcohol were found in the more soluble fractions. In pig plasma vitamin A alcohol was likewise associated with the more soluble protein.

12. Cama, H.R., Field, A.C., Glover, J., Morton, R.A. and Salah, M.K. (1952), *Biochem. J.*, **52**, 548.
13. Chanda, R. (1952), *Brit. J. Nutr.*, **6** IV.
14. Chanda, R. and Owen, E. C. (1952), *Biochem. J.*, **51**, IV.
15. Chanda, R., Clapham, H. M. and Owen, E. C. (1952), *Ibid.*, **52**, XVIII.
16. Chanda, R. and Owen, E. C. (1952). *Ibid.*, **52**, 404.
17. Chanda, R. (1952), *Ibid.*, **52**, II
18. Ganguly, J., Krinsky, N.I., Mehl, J. W. and Deuel, H. J. (Jr.). (1952), *Arch. Biochem. and Biophysics*, **38**, 275.

Zechmeister, Deuel, Inhoffen, Leemann, Greenberg and Ganguly¹⁹ examined the provitamin A activity of the synthetic compound 15-15'-central mono-cis- β -carotene with the all-trans- β -carotene in the rat and chick. It was administered to depleted rats and chicks. Given in small doses it had half the potency of all-trans- β carotene. Larger doses had less than half the potency. In hens part of the cis-carotene given was converted to all-trans carotene, but the bulk of intake was destroyed.

Deuel (Jr.), Inhoffen, Ganguly, Wallcave and Zechmeister²⁰ continued their studies on the provitamin A activity of synthetic carotene. 16-16'-homo- β -carotene ($C_{42}H_{58}$) had considerable provitamin A potency. The bioconversion of provitamin A did not appear to be molecular weight specific. One may have to revise the opinion that a completely isoprenic structure is necessary for vitamin A activity because of the presence of two carbon atoms which do not belong to any isoprenic unit in that region of the homo- β -carotene molecule against which the enzymatic attack is directed. The biopotency of the all-trans- β -carotene and of the di-cis form of homo- β -carotene are similar and can be explained by the straight molecular form of both the isomers.

Esh and Bhattacharya²¹ observed that addition of 2% α -tocopherol and 4% lecithin significantly enhanced liver storage of vitamin A fed to vitamin A deficient rats. The action of the two antioxidants was suggested to be synergistic.

Karmakar and Rajagopal²² showed that by purifying kerosene and xylene and using them in Bessey, Lowry, Brock and Lopez's method of vitamin A estimation in blood serum better results were achieved.

Sengupta²³ studied the serum carotene and vitamin A levels according to variations in dietary carotenoids. He found that 5000

19. Zechmeister, L., Deuel, H. J. (Jr.), Inhoffen, H. H., Leemann, J., Greenberg, S. M. and Ganguly, J. (1952), *Arch. Biochem. and Biophysics* **36**, 80.

20. Deuel, H. J. (Jr.), Inhoffen, H. H., Ganguly, J., Wallcave, L. and Zechmeister, L. (1952), *Ibid.*, **40**, 352.

21. Esh, G. C. and Bhattacharya, S. (1952), *Indian J. Physiol. & Allied Sciences*, **6**, 43.

22. Karmakar, G. and Rajagopal, K. (1952), *Current Science*, **21**, 193.

23. Sengupta, P. H. (1952), *Indian J. Med. Res.*, **40**, 431.

I. U. of carotene per day " prevented depletion in the serum values of these nutrients but did not cause them to rise to their former levels."

Rajagopal and Datta²⁴ made an attempt to prepare a water soluble compound of vitamin A with plasma protein. Bovine plasma albumin was prepared by low temperature ethanol fractionation. Vitamin A aldehyde was prepared according to Morton's method. At low temperature, in a medium of 40% alcohol, the two were allowed to react and the alcohol removed by dialysis. The condensation product gave a vitamin A content of 0.003% as vitamin A aldehyde in the protein vitamin A complex, and the solution contained 0.968% protein. This was roughly five times the concentration of vitamin A normally present in plasma.

Ramalingaswami and Sinclair²⁵ showed that in the rat, a hyper-plasia of the epithelium of the fore-stomach could be seen only in a mild state in uncomplicated vitamin A deficiency. If there was an associate imbalance in the intake of B vitamins, the epithelial proliferation of the fore-stomach was more marked.

Venkitasubramanian and De²⁶ fractionated shark liver oil in a MS-5 centrifugal cyclic batch still at a pressure of about 1.5 microns. The fractions distilled between 180-220° were the most potent which were also dependent on the original potency of the oil.

Vitamin D:

Dikshit and Patwardhan²⁷ carried out studies on the mode of action of vitamin D on bones. *In vitro* studies on bone slices showed that the effect of vitamin D was distinct from the effect which resulted in an increase in the concentration of calcium and phosphorus in blood. It was likely that some changes were brought about in the hypertrophic cartilage cells favourable to the utilisation of the minerals. They stressed that it was not so much

24. Rajagopal, K. and Datta, P. K. (1952), *Nature*, **170**, 370.

25. Ramalingaswami, V. and Sinclair, H.M. (1952), *Indian J. Med. Sci.*, **6**, 708.

26. Venkitasubramanian, T. A. and De, S. S. (1952), *Science and Culture*, **17**, 388.

27. Dikshit, P. K. and Patwardhan, V. N. (1952), *Indian J. Med. Sci.*, **6**, 107.

the environment as the structure and metabolic activity of the cartilage or osteoid that might determine whether or not calcium salts were deposited.

Vitamin E :

Chattopadhyaya and Banerjee ²⁸ estimated tocopherol content of cereals and several pulses by the Emmerie and Engel method. The values were found to increase after germination, being more obvious in the case of pulses.

Thiamine :

Desai ²⁹ pointed out that the values for thiamine in foodstuffs arrived at by chemical methods might indicate higher figures than actually available as judged on physiological basis. A method depending on the absorption through the intestine of rats when the nutrient was fed orally was employed and he showed that from freshly powdered wheat, the availability of the vitamin was 100% while in the case of *Jowar*, *Bajri*, *Chauli*, rice and green pea it varied from 75 to 90%. Cooking did not appear to change availability of the vitamin. Hatwalne and Sohonie ³⁰ estimated the thiamine content in palmyra gur and date palm gur, employing the thiochrome method. For the palm variety, the values obtained were 20.5 μ g. (1.7 to 29.7 μ g.) per 100 g. The corresponding values for date gur were 22.7 μ g. (18.2 to 29.6 μ g.) per 100 g. The surprising thing was that inspite of the high temperature and alkaline pH involved in the preparation of the gur, the material showed such high values.

Sathe, Venkitasubramanian and De ³¹ found that ammonium sulphate with compost (40 lbs. and 20 lbs. per acre respectively) increased the thiamine content of rice upto 2.94 Y/g. from 2.58Y/g.

28. Chattopadhyaya, H. and Banerjee, S. (1952), Food Res., **17**, 402.

29. Desai, D. B. (1952), Indian Physician, **11**.

30. Hatwalne, B. V. and Sohonie, K. (1952), Current Science, **21**, 349.

31. Sathe, V., Venkitasubramanian, T.A. and De, S. S. (1952), Science and Culture, **18**, 34.

Balakrishnan and De³² conducted experiments on rats fed diets containing varying levels of protein (casein) at 5, 15 and 25% levels and their effect on thiamine excretion. The intestinal synthesis of thiamine was greater when vitamin and protein intake were low. They³³ also showed that a diet low in P had a slightly more favourable effect on the intestinal synthesis of thiamine. Balakrishnan and Rajagopalan³⁴ feeding diets containing 5%, 15% and 40% protein to rats confirmed the earlier conclusion of Balakrishnan and De³². The increased excretion of thiamine by rats fed 5% protein was not due to a greater depletion of the body store but to increased intestinal synthesis. The same workers³⁵ also studied the effect of milk and curd on the intestinal synthesis of thiamine. Balakrishnan and De³⁶ observed that the intestinal synthesis of thiamine in rats as indicated by urinary excretion, was pronounced when the diet had a high fat content and raising the protein level in the high fat diet produced enhanced excretion of the vitamin in urine.

Raychaudhuri³⁷ drew attention to the toxicity of thiamine hydrochloride in certain susceptible individuals. The vitamin was given as an injection and the patient had presented himself for a relapse of his condition of neuralgic pains and wasting. After giving a detailed description of the signs and symptoms which developed after the injection, he stated that the manifestations might not be allergic.

Riboflavin:

Desai²⁹ showed that the availability of riboflavin was higher from cereals than pulses when the absorption of the vitamin through the intestines of the rat was used as the criterion. In rice and *Bajri* it was 100 per cent, while in the case of wheat and *Jowar* it was 75%. The pulses, green pea and *Chauli* gave 56% while

32. Balakrishnan, S. and De, S. S. (1951), Indian J. Physiol. and Allied Sci., **5**, 90.

33. *Idem*, (1952), *Ibid.*, **5**, 123.

34. Balakrishnan, S. and Rajagopalan, R. (1952), Current Science, **21**, 134.

35. *Idem*, (1952). *Ibid.*, **21**, 135.

36. Balakrishnan, S. and De, S. S. (1952), Indian J. Physiol. and Allied Sci., **6**, 1.

37. Raychaudhuri, A. K. (1952), J. Indian Med. Assoc., **22** 27.

lentil gave only 27%. Cooking had no effect on the availability. Hatwalne and Sohonie³⁰ analysed palmyra and date palm *gur* for riboflavin content. The values were 424 μg . (353 to 452) per 100 g. for palmyra *gur* and 438 μg . (420 to 460) per 100 g. for date palm *gur*. Ghosh and Rajagopal³⁸ estimated the riboflavin content of some common Indian foodstuffs. They used microbiological assay procedure using *Lactobacillus casei* as the test organism. They found that curry leaves (*Murrya paniculata* Spreng) and *Patel* leaves (*Trichosanthes dioica* Roxb) were rich sources containing 200 and 225 γ per 100 g. Green peas and papaya gave 80 and 100 γ per 100 g. The dried pulses gave values ranging from 150 to 300 γ per 100 g.

De, Datta and Roy³⁹ tried several antibacterial and therapeutic agents on the biosynthesis of riboflavin in the rat. Sulpha drugs of pyrimidine group, such as sulpha dimethyl pyrimidine and sulpha diazine, increased riboflavin excretion of test doses to a considerable extent. The significance of the increased excretion is discussed. Mitra⁴⁰ used a mutant top yeast (yeast strain BY₂) for production of riboflavin.

Nicotinic Acid :

Chaudhuri⁴¹ reported a colorimetric method of estimation of nicotinic acid using para amino benzoic acid as the coupling reagent. The specificity of the reagent was tested and it was found that nicotine and pyridine would interfere. Pyridine could be eliminated during the process of extraction and nicotine was not ordinarily a constituent in biological materials requiring assay. Using the new coupling reagent the colour was more intense and was a definite advantage. The nicotinic acid content of several biological materials was estimated and compared with the older established methods. Hatwalne and Sohonie³⁰ estimated the nicotinic acid content of palmyra and date palm *gur* using the cyanogen bromide method. The values were 4.2 mg. (3.1 to 5.1)

38. Ghosh, A. K. and Rajagopal, K. (1951), Indian J. Med. Res., **39**, 473.

39. De, H. N., Datta, P. and Roy, J. K. (1951), *Ibid.*, **39**, 353.

40. Mitra, K. K. (1952), J. Sci. and Indust. Res., India, **11B**, 109.

41. Chaudhuri, D. K. (1951), Indian J. Med. Res., **39**, 491.

and 4.2 mg. (3.9 to 4.5) per 100 g. respectively. Karkun and De⁴² adopted the cylinder plate method for the assay of nicotinic acid in drugs and galenicals using *Lactobacillus arabinosus* as the test organism. Reddi⁴³ described a method of estimation of the bound form of nicotinic acid in which he turned to advantage the earlier observation made by him and Kodicek, that the bound form of nicotinic acid did not move on paper chromatograms developed in n-butanol water solvent system or in 60% n-propanol.

De and Guha⁴⁴ interested themselves in finding out the conditions for the biosynthesis of nicotinic acid in the rat. They studied the effect of various carbohydrates in a nitrogen-free, nicotinic acid-free diet on the rats. The nicotinic acid excretion when starch, dextrin, agar agar and glucose were present in the diet was found to be much higher than when sucrose formed the carbohydrate of the diet. It was found that the intestinal flora could use ammonium salt for the biosynthesis of nicotinic acid but failed when potassium nitrate was substituted. Asparagine, and asparagine with the addition of methionine, did not stimulate biosynthesis of nicotinic acid although in laboratory synthetic process they were readily utilised. They⁴⁵ carried out *in vitro* studies using liver and kidney tissue of the rat incubated in a medium containing different sources of nitrogen. Both liver and kidney could convert l-tryptophane into nicotinic acid when the tissues were incubated for 4 hours at 37°C. The liver could form nicotinic acid more efficiently than the kidney. l-promine could not stimulate the biosynthesis. Out of ammonium sulphate and potassium nitrate the former only could promote nicotinic acid synthesis indicating that inorganic nitrogen source in the form of ammonium ion could act as precursor in the synthetic process. Pyridoxine and folic acid accelerated the conversion of tryptophane to nicotinic acid, but thiamine failed to do so. In concentrations of 100 μ g, Fe, Cu, and Mn had a stimulatory effect but when the concentration rose to

42. Karkun, J. N. and De, S. P. (1952), Indian J. Med. Res., **40**, 272.
43. Reddi, K. K. (1952), Nature, **170**, 747.
44. De, H. N. and Guha, S. R. (1951), Indian J. Med. Res., **39**, 337.
45. *Idem*, (1951), *Ibid.*, **39**, 343.

1000 μ g. the process was retarded. De, Datta and Roy⁴⁶ tried the effect of some antibacterial substances and found that the sulpha drugs of pyrimidine group, such as sulphadimethyl pyrimidine and sulpha diazine, increased the elimination of nicotinic acid in rats.

Banerjee, Ghosh and Nandi⁴⁷ observed during germination an increase in nicotinic acid and nicotinuric acid content of pulses and cereals among the ten varieties of the former and three of the latter studied. It was noticed that in pulses the trigonelline content diminished during germination while the N¹-methyl nicotinamide increased, the value becoming maximal on the third day of germination. The hypothesis was put forward that in pulses, the trigonelline was converted to N¹-methyl nicotinamide and after demethylation gave rise to nicotinic acid. Cereals did not contain trigonelline and N¹-methyl nicotinamide and hence the method of synthesis in them was different to that occurring in the pulses. Ghosh, Nandi and Banerjee⁴⁸ found an alkali labile bound form of nicotinic acid in fish and in the muscle of tortoise, but not in beef and goat meat. The bound form of the vitamin appeared to be in combination with proteins and carbohydrates. This bound vitamin was different from the one present in cereals.

Pyridoxine :

Tulpule and Patwardhan⁴⁹ studied the effect of deficiencies of pyridoxine and fat on certain enzyme systems in the rat liver. In fat deficiency, and in combined fat and pyridoxine deficiency, the succinic dehydrogenase activity was reduced. Glutamic dehydrogenase activity in liver was reduced in single deficiencies of either pyridoxine or fat and in their combined deficiencies the reduced activity was marked. In fat deficiency, butyric dehydrogenase activity was reduced, whereas with pyridoxine deficiency no change was observed. They found a direct correlation between the iodine

46. De, H. N., Datta, P. and Roy, J. K. (1951), Indian J. Med. Res., **39**, 353.

47. Banerjee, S., Ghosh, N. C. and Nandi, N. (1951), *Ibid.*, **39**, 447.

48. Ghosh, N. C., Nandi, N. and Banerjee, S. (1951), *Ibid.*, **39**, 453.

49. Tulpule, P. G. and Patwardhan, V. N. (1952), Arch. Biochem. and Biophysics, **39**, 450.

value of fatty acids of liver and glutamic and butyric dehydrogenase in liver.

Biotin :

Sivasankar, Tirunarayanan and Sarma⁵⁰ found that sodium or potassium oleate could replace biotin far more efficiently than soaps of palmitic and stearic acids in the nutrition of a cholineless mutant of *Neurospora crassa*. This superiority was not related to the function of biotin in desaturating fatty acids. Biotin was found to stimulate the assimilation of the nitrogen and production of fat in *Neurospora crassa*. If the medium contained biotin, it was found that the mycelia obtained had the ability to deaminate aspartic and glutamic acids, serine and alanine about one to four times more efficiently than when biotin was not included in the medium. Sivasankar and Sarma⁵¹ using rice moth larva showed that when biotin was present in the diet there was an increased utilisation of protein nitrogen and carbohydrate from the diet and formation of fat. On a biotin deficient diet uric acid excretion of larva diminished which was comparable to the drop in urea excretion noted in the rat in similar conditions. It might be interpreted that biotin facilitated deamination of amino acids with the formation of keto-acids, which in turn led to synthesis of fat, while the ammonia was excreted as uric acid.

Folic Acid :

Benjamin Allan⁵² made observations on 15 patients suffering from anaemia associated with pregnancy. Cases of severe anaemia showing macrocytic blood picture and high MCV were selected. The patients were put on a diet which included 1 lb. of fresh milk and 2 oz. of fish daily. Two ml. of a folic acid compound (a proprietary preparation containing per ml. 0.5 mg. folic acid, 0.6 mg. folic acid conjugate and extract of 15 g. of liver) were administered daily and in ten days the response was very good. The blood picture improved rapidly and a good reticulocyte response was

50. Sivasankar, D. V., Tirunarayanan, M. O. and Sarma, P. S. (1952), J. Sci. and Indust. Res. India, **11B**, 63.

51. Sivasankar, D. V. and Sarma, P. S. (1952), *Ibid.*, **11B**, 394.

52. Benjamin Allan, A. (1952), J. Indian Med. Assoc., **21**, 206.

observed in 7-10 days. The blood count doubled in the same period. The MCV steadily diminished and returned to normal.

Using pieces of isolated ileum of guinea pig, Govinda Rao⁵³ found that folic acid was able to prevent the spasm of the intestine caused by acetyl choline while this result was not achieved in the histamine induced spasm.

Fatterpaker, Marfatia and Sreenivasan⁵⁴ studied the relationship between nicotinamide methyl kinase and folic acid. Mice were put on a folic acid free diet containing 15 μ g. vitamin B₁₂ per cent and 0.3 per cent iodinated casein. At the end of 5 weeks they were given 10 μ g. folic acid orally per rat per day or 1 mg. methanol or formate intraperitoneally. N¹-methyl nicotinamide was estimated in urine. Pooled liver homogenates were incubated with methionine and nicotinamide. It was found that dietary folic acid influenced methylation of nicotinamide *in vitro* and *in vivo*. They⁵⁵ attributed this effect of dietary folic acid in part at least to a check on drain of methyl to formate. In their opinion, it was possible that methanol might also contribute to methyl neogenesis in view of their observation that folic acid did not specifically catalyse the synthetic step. The impairment of creatine metabolism in folic acid deficiency was partially restored by formate or methanol and they tested the validity of this, using mice.⁵⁶

Vitamin B₁₂:

Bose and Ghosh⁵⁷ studied several methods of vitamin B₁₂ assay. The tube assay gave a much lower value than the cup-plate method. They suggested that the liquid tube assay with *Lactobacillus leichmanni* detected and measured only vitamin B₁₂, out of the various components B_{12a}, B_{12b}, B_{12c}, or B_{12d}, as well as other non-specific stimulants, such as thymidine and desoxyribonucleosides. With crude liver extracts and liver powders the

53. Govinda Rao, A. R. (1952), Indian J. Med. Sci., **6**, 364.

54. Fatterpaker, P., Marfatia, U. and Sreenivasan, A. (1952), Nature, **169**, 1096.

55. *Idem*, (1952), *Ibid.*, **169**, 1097.

56. *Idem*, (1952), *Ibid.*, **170**, 895.

57. Bose, A. N. and Ghosh, S. (1952), Science and Culture, **18**, 44.

cup-plate method gave high values which on paper chromatography came down though still higher compared with liquid tube assay.

Mariakulandai and McGinnis⁵⁸ made the observation that the CO₂ production of chick embryos *in vivo* on the 18th, 19th and 20th days of incubation was higher in the case of vitamin B₁₂ supplemented embryos. This was evident even when the partial pressure of oxygen was increased. This increased CO₂ production was in their opinion related to the higher haemoglobin formation in the vitamin B₁₂ supplemented embryos. The same workers in association with Myiul⁵⁹ found in the white leghorn that the addition of terramycin and vitamin B₁₂ to the diet had no effect on weight gain or egg production, but in the absence of vitamin B₁₂ the hatching capacity of the fertile eggs improved. The improvement was not associated with an increase in the vitamin B₁₂ content of the egg.

Vijiaraghavan and Dunn⁶⁰ studied the effect of thymidine, citrovorum factor, folic acid and degradation products of vitamin B₁₂ on red blood cell counts in experimental anaemia in male mice. Anaemia was induced by the intraperitoneal injection of phenylhydrazine hydrochloride. Injections of 300 μ g. of the citrovorum factor and vitamin B₁₂ in 2 μ g. dose increased the red blood cell count. Anti-anaemic activity was not observed with thymidine, α -ribazole-1d-ribityl 5, 6-dimethyl benzimidazole and 1, 2-diamino 4, 5-dimethyl benzene. A synthetic product, 2, 5-dimethyl benzimidazole inhibited red cell formation.

Vitamin BT:

Vitamin BT the meal worm factor which occurs in high concentration in muscle was shown to be carnitine by Carter, Bhattacharyya, Weidman and Fraenkel,⁶¹ substantiated by

58. Mariakulandai, A. and McGinnis, J. (1952), Arch. Biochem. and Biophysics, **37**, 136.

59. Mariakulandai, A., Myiul, J. and McGinnis, J. (1952), Proc. Soc. Expt. Biol. & Med., **79**, 242.

60. Vijiaraghavan, P. K. and Dunn, M. S. (1952), Arch. Biochem. and Biophysics, **36**, 299.

61. Carter, H. E., Bhattacharyya, P. K., Weidman, K. R. and Fraenkel, G. (1952), *Ibid.*, **35**, 241.

chemical analysis. They⁶² isolated vitamin BT as a pure crystalline substance from liver and whey. Analytical data and a careful study of the properties and derivatives of vitamin BT and carnitine left no doubt that the two were identical.

Unclassified :

Clegg, Kodicek and Mistry⁶³ modified Teply and Elevehjem's medium for assay of B vitamins using *Lactobacillus casei*. It contained casein hydrolysate and norite heated peptone. The optimum concentration was determined for salts, glucose, cystine, tryptophan, alanine, purine, pyrimidine and B vitamins. It proved satisfactory for the assay of riboflavin, nicotinic acid, pantothenic acid and biotin. For folic acid and its conjugates the titrimetric method was more suitable than the turbidimetric. Pteroic acid and rhizopterin were inactive for *L.casei*. Ramakrishnan and Banerjee⁶⁴ studied the effect of supplementing several vitamins on the growth and activity of a lipolytic mould. A strain of *Aspergillus niger* isolated from the castor bean showed high lipolytic activity. This was grown on a medium containing 15% oil-free groundnut cake, 10% fresh groundnut oil and 200 ml. water, and adjusted to pH 4.2 and incubated at 35° C for 4 days. The effect of addition of several vitamins, digitonin and cholesterol on the growth of the mould was tried. It was found that digitonin inhibited growth. Growth was enhanced in the medium to which were added cholesterol, vitamin B₂ or α -tocopherol.

Ascorbic Acid :

The average concentration of ascorbic acid in the milk of healthy Bengali women was found by Bagchi⁶⁵ to be 6.7 mg. per 100 ml. and the concentration in plasma was 0.78 mg. per 100 ml. The figures were the average for 1st to 7th month of lactation. Apparently the infant thriving on breast milk in Bengal was getting its requirement of ascorbic acid. Banerjee and Deb⁶⁶

62. Carter, H. E., Bhattacharyya, P.K., Weidman, K.R. and Fraenkel, G. (1952), *Arch. Biochem. and Biophysics*, **38**, 405.

63. Clegg, K. M., Kodicek, E. and Mistry, S. P. (1952), *Biochem. J.*, **50**, 326.

64. Ramakrishnan, C. V. and Banerjee, B. N. (1951), *Nature*, **168**, 917.

65. Bagchi, K. K. (1952), *Indian Med. Gaz.*, **87**, 198.

66. Banerjee, S. and Deb, C. (1952), *J. Biol. Chem.*, **194**, 575.

were of the opinion that in scorbutic guinea pigs, hypofunctions of the adrenal cortex was evident. They estimated 17-ketosteroids in urine of scorbutic and pair-fed normal female guinea pigs and the results were in support of their claim. Banerjee, Deb and Belavady⁶⁷ estimated the glutathione and dehydroascorbic acid content in tissues of guinea pig on scurvy producing diet and pair-fed normal animals. No change in glutathione content was observed in kidney tissue and the small intestines. It was reduced in the blood, adrenals, pancreas, spleen and liver of scorbutic animals. This was marked in the pancreas. Dehydro-ascorbic acid was present in the adrenals, pancreas, spleen, liver, kidney and small intestine of scorbutic guinea pigs. It was not detected in the normal animals. It was suggested that the diminished insulin secretion in scorbutic guinea pigs might be the result of the combined effect of diminished glutathione and increased dehydro-ascorbic acid content of the tissues and in particular the pancreas.

The stability of vitamin C in "Neera" (fresh juice from date palm *Phoenix sylverstris*) at 37°C was the subject of an investigation by Guttikar and Sohoni⁶⁸. Vitamin C was found to be stable, 90% of it was retained even after 15 days storage. The pH was found to have changed from 7.5 to 3.0 due to fermentation. The stability of vitamin C was ascribed not so much to the lowered pH, but to the presence of (SH) compounds in *neera* which would protect vitamin C from oxidation. A positive nitroprusside test was in favour of the presence of such protective substance. Hatwalne and Sohoni³⁰ determined the vitamin C content of Palmyra and date palm *gur* using the redox dye 2:6-dichlorophenol indophenol. The values were 19.4 mg. (9.3 to 33.3) and 18.3 mg. (5.2 to 30.0) per 100 g. respectively.

Kalyanasundaram⁶⁹ studied the ascorbic acid content of wilt infected plants under laboratory and field conditions. It was found that these vascular wilts brought about a striking reduction in the ascorbic acid content of leaves of both hosts and also an increase in

67. Banerjee, S., Deb, C. and Belavady, B. (1952), *J. Biol. Chem.*, **195**, 271.

68. Guttikar, M. N. and Sohoni, K. (1952), *Current Science*, **21**, 137.

69. Kalyanasundaram, R. (1952), *Proc. Indian Acad. Sciences*, **36B**, 102.

the reducing sugar content. It was concluded that dechlorophyllation and retarded growth which seemed to precede the actual wilting of plants caused a decrease in the ascorbic acid content.

Mukherjee⁷⁰ drew attention to the prevalence of infantile scurvy in hospital practice in Calcutta which appeared more common than generally believed. The diagnostic points, particularly joint pains which might sometimes elude the physician if he is not thinking of the possibility of scurvy, are discussed.

In the course of an investigation on acetoacetate induced changes in blood lactic acid and its prevention by insulin and amellin, Nath and Chakrabarti⁷¹ observed that in an experiment lasting 60 days when the daily amount of acetoacetate injected in rabbits was 25 mg. as sodium acetoacetate, there was a drop in plasma ascorbic acid value from 2.50 mg. to 0.83 mg. per 100 ml.

An *in vivo* evaluation of the bacteriostatic properties of vitamin C was made on several microorganisms by Sirsi.⁷² The vitamin did not inhibit the growth of staphylococci, streptococci, *B. coli* and *E. typhosus*. With *M. tuberculosis*, the results were interesting. The vitamin possessed tuberculostatic properties against virulent strains of the organism in high dilution. An increase in the amount of inoculum reduced the tuberculostatic property of the vitamin. *M. tuberculosis* was grown on modified Proskauer and Beck media. 100 μ g./ml. vitamin C added to this was bactericidal in one week and the effect lasted for 3 months. With a dilution of 10 μ g./ml. inhibition of growth was observed for 3 weeks and then the effect waned.

Chattopadhyay and Banerjee⁷³ studied the ascorbic acid oxidase activity of some common Indian pulses during germination. It was absent in the pulses in the ungerminated state. The enzyme began to appear after a day's germination and the value steadily

70. Mukherjee, D. N. (1952), *J. Indian Med. Assoc.*, **21**, 510.

71. Nath, M. C. and Chakrabarti, C. H. (1951), *Proc. Soc. Exp. Biol. & Med.*, **78**, 369.

72. Sirsi, M. (1952), *Indian J. Med. Sci.*, **6**, 252.

73. Chattopadhyay, H. and Banerjee, S. (1952), *Indian J. Med. Res.*, **40**, 439.

increased till the 3rd day and was retained till the 5th day of germination. The decreased ascorbic acid content and increased dehydroascorbic value on the 4th or 5th day of germination appeared to be connected with the formation of the ascorbic acid oxidase at this time.

Nath, Chitale and Belavady ⁷⁴ carried out experiments on the biosynthesis of vitamin C by *Phaseolus mungo*. The effect of adding either glucose or sodium acetoacetate and of both and of a condensation product of the above two substances namely, 2-tetra hydroxy butyl, 5-methyl, 4-carbethoxy furan, the structure of which resembles ascorbic acid, were tried. While with the addition of either of the components, no striking result was achieved, the addition of the condensation product increased the quantity of vitamin C to 100% and more in 9 hours. Shah and Sreenivasan's ⁷⁵ work supported the view that the conversion of glucose to ascorbic acid took place through the glycolytic route rather than by direct oxidative pathway. Using *P. mungo* they showed that thiamine, riboflavin and nicotinic acid catalysed the oxidative breakdown steps that resulted in the formation of ascorbic acid from glucose. Fumaric and succinic acids stimulated biogenesis of vitamin C. The selective inhibitors concerned in glucose breakdown, such as azides, iodo-acetate, fluoride and 2 : 4-dinitrophenol had inhibitory effect on ascorbic acid formation. Parallel results were obtained in respect of nicotinic acid. Malonate, a competitive inhibitor of succinic dehydrogenase, depressed ascorbic acid formation.

Sengupta, Sanyal, Bhattacharyya and Mathen ⁷⁶ observed that in case of Kala Azar there was a significantly higher incidence of vitamin deficiency, particularly of vitamin A, B complex and vitamin C. It was probable that vitamin A deficiency resulted due to hepatic dysfunction in Kala Azar.

74. Nath, M.C., Chitale, R. P. and Belavady, B. (1952), Nature, 170, 545.

75. Shah, Y. S. and Sreenivasan, A. (1952), Current Science, 21, 161.

76. Sengupta, P. C., Sanyal, N. V., Bhattacharyya, B. and Mathen, K. K. (1952), Indian Med. Gaz., 87, 444.

HUMAN NUTRITION

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The output of work in this field has fallen slightly during the year under review. However, the subjects of immediate importance in India such as the nutritive value of foodstuff, substitute foods; and deficiency diseases, such as nutritional oedema, cirrhosis of the liver, lathyrism, fluorosis, etc., have continued to attract the attention of investigators.

Food Problem :

With the available data Subrahmanyam¹ observed that in India, over the last some years, there have been very few years of excess production and more years of food shortage. To bridge this gap the author points out that the Central and the various State Governments are executing several irrigation projects, both to increase the yield per acre and to bring in more land under the plough; however, the full benefits of these may not be reaped for some years to come. To make good the shortage in the immediate future, he advocates the cultivation of cassava (*Manihot utilissima*) on an increased acreage, since this is a plant which is able to give greater return per acre of land in terms of energy value than cereals and, further, has a low water requirement. When all the present projects are completed and the normal food requirements met from cereals, cassava which might be surplus as food will still be useful in the economy of the country for the manufacture of starch which is at present being imported to meet the demands of the textile industry.

Clinical, physiological and field studies :

de Mello,² who has experience of *kwarshiorkor* in Africa, after visiting some famine areas in India, observed that among the

1. Subrahmanyam, V. (1952), *J. Sci. and Indust. Res., India*, **11A**, 437.

2. de Mello, J. P. (1952), *Indian Jour. Med. Sci.*, **6**, 140.

famine cases there were clinically some features seen commonly in cases of *kwarshiorkor* in Africa. He expressed the opinion that in India even those people who could afford to have a better diet did not consume sufficient quantity of animal proteins because of religious objections to eat meat, fish and eggs and only consumed an unbalanced diet made up largely of cereals. He pleaded for a more rational outlook on life and food habits on the part of the people in India.

Rajagopal and Chowdhury³ estimated total lipids, cholesterol, total fatty acids in blood serum and its iodine number and found their average to be lower in the 24 phrynoderm cases than in 45 normals they investigated. The average values of total lipids in blood serum of phrynoderm and normal cases were 443 and 485 mg./100 ml. respectively. The iodine number of the lipids in the corresponding cases were 94 and 114 respectively. The phrynoderm cases were administered per day three-fourths of an ounce of raw linseed oil by mouth for a period extending upto 24 weeks. Improvement was seen in 2 weeks and complete cure was achieved in all cases in 4 to 24 weeks. With improvement in clinical condition, the values in blood serum of the different constituents enumerated above tended to rise to those of the normals. The authors concluded that a deficiency of essential unsaturated fatty acids played a part in the causation of phrynoderm.

Rudra and Chowdhury⁴ estimated the urinary excretions of methionine in 24 normal persons and 22 lathyrism cases who were still continuing to consume *Lathyrus sativus* and found them to be 447 ± 120 mg. and 84 ± 47 mg., respectively. When 6 of the lathyrism cases gave up eating *L. sativus* the values rose to 379 ± 106 mg. The authors suggested that the decreased methionine excretion in lathyrism might be due to alteration in the structure of methionine caused by the toxic factor present in *L. sativus*. In continuation of this work, Rudra *et al*⁵ reported the effect of treat-

3. Rajagopal, K. and Chowdhury, S. R. (1952), Indian Med. Gaz., **87**, 350.

4. Rudra, M. N. and Chowdhury, L. M. (1952), Current Science, **21**, 99.

5. Rudra, M. N., Chowdhury, L. M. and Sinha, S. P. (1952), Indian Med. Gaz., **87**, 89.

ment of lathyrism with methionine administered parenterally to 5 male lathyrism cases of ages ranging from 10 to 40 years. The duration of the disease was one month in one case and in others it was more than 2 years. They were given 1 to 1.2 g. of methionine per day; the total dose for each person ranged from 4.8 g. to 19.0 g. Babinski's sign was totally abolished in 2 of the cases and one of these regained 75% of the normal gait.

Someswara Rao *et al*⁶ made an exhaustive review of the present knowledge regarding the relation between nutrition and sex glands. They laid special emphasis on the damage caused to the sex glands by faulty nutrition, more especially that due to deficiency of protein in the diet. The authors mentioned that in their experience, nutritional oedema in children responded to treatment with skimmed milk powder better if in addition small doses of testosterone were administered. Gopalan *et al*⁷ investigated 39 cases of nutritional oedema of a duration of 15 to 80 days. They described in detail the clinical features of these cases. The biochemical investigations carried out included the levels of serum protein fractions, serum sodium and chloride, and glucose tolerance. There was appreciable lowering in total plasma proteins in all cases due entirely to the fall in albumin levels. The plasma sodium level in all the 18 cases investigated, and the plasma chloride levels in all the 7 cases investigated, were normal or below normal. The oral glucose tolerance test was carried out in 9 cases and was found to be abnormal; in two of these cases the intravenous test was also carried out. The abnormal oral glucose tolerance curves observed were attributed to delayed alimentary absorption of glucose. Anaemia of varying degrees was found in all the cases investigated. The predominant type of blood picture was a normochromic macrocytic type of anaemia associated with an early normoblastic bone marrow. Histological changes in the various organs from specimens obtained at biopsy and autopsy from 5 cases, who died during the investigation, have been described. The

6. Someswara Rao, K., Venkatachalam, P. S. and Gopalan, C. (1952), Indian Jour. Med. Sci., **6**, 37.

7. Gopalan, C., Venkatachalam, P. S., Someswara Rao, K. and Menon, P. S. (1952), Indian Jour. Med. Sci., **6**, 277.

treatment adopted was rest in bed, usual hospital diet which supplied 55 g. protein and 2300 calories and in addition skimmed milk powder (made into a paste) given at 2 ounces on the first day rising to 5 ounces on the tenth day. Under this treatment, the patients improved markedly and oedema disappeared in 3 to 4 weeks in most cases. Gopalan and Venkatachalam⁸ in the light of their experience, discussed the existing hypothesis for the causation of nutritional oedema and found that none of them fully met all the facts observed. They suggested an alternative hypothesis according to which, in cases of nutritional oedema, there might be increased presence of an antidiuretic substance in the blood serum (which might be the antidiuretic hormone of the pituitary) and which might prevent the normal excretory response to water administration and cause hemodilution with resultant fall in intravascular osmotic pressure and diffusion of fluid to interstitial tissue spaces.

Chaudhuri and Chakravarty⁹ administered by mouth half or one ml. of white oil (mineral oil) per pound of body weight per day to 3 monkeys weighing between $5\frac{1}{2}$ to 9 lbs. fed the usual basal diet. Two of the monkeys died after 11 and 21 days respectively, and the third was killed after 3 months. *Post-mortem* examination of the monkeys showed all the organs to be congested, more particularly, the liver, kidneys, heart and spleen. The chief action was on the blood vessels and was of the same nature as that seen in animals with argemone poisoning.

Vijayaraghavan and Patwardhan^{10,11} reviewed the existing knowledge of the different nutrients, a deficiency of which might cause liver damage. To study the influence of poor rice diet on livers, they maintained two groups of young albino rats, one on a stock colony diet (containing 0.260% methionine) and the other on a poor rice diet (containing 0.120% methionine) for

8. Gopalan, C. and Venkatachalam, P. S. (1952), Indian Jour. Med. Sci., **6**, 713.

9. Chaudhuri, R.N. and Chakravarty, N. K. (1952), *Ibid.*, **6**, 137.

10. Vijayaraghavan, P. K. and Patwardhan, V. N. (1952), Current Science, **21**, 120.

11. *Idem*, (1952), Indian Jour. Med. Sci., **6**, 696.

23 months. At intervals of 3 months, one or more animals in each of the groups were sacrificed and fat in the liver estimated. Livers of animals receiving the poor rice diet had abnormally high amounts of fat (average 7%) as compared with those on stock diet (average 4.5%). Supplements of choline (1 mg. per rat per day) or DL-methionine (4 mg. per rat per day) to the poor rice diet brought down the level of fat in the livers to those of the stock group.

Karambelkar *et al*¹² reported the urinary creatinine excretion of 7 human subjects on diets containing either low or high proportion of animal protein, the total protein intake being maintained at the same level for each subject during the two periods. Substitution of animal proteins for vegetable proteins in the diet caused 8 to 21% increase in creatinine excretion in 4 of the subjects.

Gilroy¹³ carried out a clinical nutrition survey in 1948-49 of 4191 children living on 44 tea estates in Assam. Xerophthalmia was very common (69.7%), dry skin moderately common (15.9%) but phrynodermia was absent. Vitamin A intake was low. To some of the children, vitamin A was administered at 3000 I. U. per day for 7 months. Though there was a decrease in the degree of the severity of xerophthalmia, the response was considered unsatisfactory for the total quantity of vitamin administered.

Nutritive value of foodstuffs :

Lal and Mitra¹⁴ investigated the effect of cooking on proximate principles and the important minerals, calcium, phosphorus and iron, of 12 Biharee food dishes. The general conclusions they reached were that there was a small loss in calories and fat in all the cooked dishes; and a small increase in iron in most of the dishes due to the use of iron vessels for cooking. In the case of other nutrients there was no marked difference between the values in the raw and cooked states.

12. Karambelkar, P.V., Patwardhan, V.N. and Sreenivasan, A. (1952), Indian Jour. Med. Res., **40**, 89.

13. Gilroy, A. B. (1951), *Ibid.*, **39**, 361.

14. Lal, S. B. and Mitra, A. R. (1952), Indian Med. Gaz., **87**, 172.

The supplementing of a poor rice diet with one per cent crude common salt improved the rate of growth of young rats over that of the poor rice diet.¹⁵ This enhanced growth promoting property was attributed to the presence of calcium (0.60%) and other mineral impurities present in crude common salt.

Sreenivasan¹⁶ discussed the problem of the nutrition aspects of milling of cereals and advocated artificial enrichment of milled cereals with some of the more important vitamins to improve the health of the people in India.

Proteins, fats and carbohydrates :

The proteins of tapioca were purified by electrodialysis by Narayana Rao *et al*¹⁷ and found to contain 10.5% nitrogen and 1.03% ash. Analysis of the protein showed it to contain 3.5% histidine (calculated to 16 g. of nitrogen) and no methionine. Experiments with rats to test the proportion in which tapioca had to be combined with rice to maintain life in young rats and nitrogen equilibrium in adult rats showed it to be 40 parts to 30 parts per 100 g. of diet.

Subramanian *et al*¹⁸ studied the nutritive quality of proteins in the seed of *Sesbania grandiflora*, as it contained 69.9% protein (Nx 6.25). They studied the biological value of the proteins by the balance sheet and growth methods and also its use as supplement to a poor rice diet. From the results obtained, they concluded that the proteins of the seed were grossly deficient in one or more essential amino acids. By paper chromatography, they obtained evidence that the protein might be deficient in lysine and the sulfur containing amino acid.

Dutta and Dutta¹⁹ reviewed, in a fairly exhaustive manner, the present knowledge of the essential amino acids in human

15. Subramanian, N., Sur, B. K. and Subrahmanyam, V. (1952), Current Science, **21**, 190.

16. Sreenivasan, A. (1952), J. Sci. and Indust. Res. India, **11A**, 297.

17. Narayana Rao, D., Sreeramamurthy, V. V. and Venkateswaralu, P. (1951), Indian Jour. Med. Res., **39**, 329.

18. Subramanian, N., Lakshminarayana Rao, M. V. and Srinivasan, M. (1952), Current Science, **21**, 339.

19. Dutta, N. C. and Dutta, N. C. (1952), Indian Jour. Med. Sci., **6**, 58.

nutrition citing some 42 references. Udupa²⁰ laid stress on the importance of proteins and vitamin C in surgical patients. He suggested that at least 120 g. of protein and 2,000 calories should be given to a patient weighing 150 pounds.

Using *L. arabinosus* 17-5, Balasubramanian *et al*²¹ assayed by the microbiologically method, the cereals rice, cholam (*Sorghum vulgare*), ragi (*Eleusine coracana*), Cambu (*Pennisetum typhoideum*) and wheat, for their content of tryptophane, leucine, isoleucine and valine. Contradicting the report of Lal (Indian Jour. Med. Res., **38**, 131, 1950) that Bengal gram did not contain threonine, Srinivasan and Vijayaraghavan²² found by microbiological assay using *S. faecalis*, R that it contained 8.10 g. per 100 g. of protein. They also showed that Bengal gram protein was adequate for growth and maintenance of white rats.

Ramachandran and Sarma²³ made *in vitro* studies of the liberation of serine and threonine from casein, edestin, egg albumin, fibrin and gliadin when these were subjected to hydrolysis by pepsin, trypsin, erepsin and papain. During peptic digestion 5 to 11% of the total threonine and 7 to 14% of the total serine present in the protein were liberated. They discussed the significance of rate of hydrolysis for producing individual amino acids and its bearing on nutrition.

Govindarajan and Ramachandran²⁴ assayed eleven oil seed cakes for their content of L-lysine using a decarboxylase preparation and measuring the evolved carbondioxide in a Warburg manometer. The lysine values ranged from 0.5% for linseed to 3.3% for Papri (*Holoptolea integrifolia*). Phatak and Patwardhan²⁵

20. Udupa, K. N. (1952), Indian Jour. Med. Sci., **6**, 456.

21. Balasubramanian, S. C., Ramachandran, M., Viswanatha, T. and De, S. S. (1952), Indian Jour. Med. Res., **40**, 73.

22. Srinivasan, P. R. and Vijayaraghavan, P. K. (1952), Current Science, **21**, 101.

23. Ramachandran, L. K. and Sarma, P. S. (1952), J. Sci. and Indust. Res., India, **11B**, 379.

24. Govindarajan, V. S. and Ramachandran, B. V. (1952), *Ibid.*, **11B**, 477.

25. Phatak, S. S. and Patwardhan, V. N. (1952), *Ibid.*, **11B**, 533.

showed that iso-oleic acid separated from hydrogenated groundnut oil was well digested and utilized by albino rats.

Damodaran and Siva Raman²⁶ studied the effect of different dietary fats on liver fat deposition on rats maintained on low protein diets. Ghee and coconut oil caused pronounced infiltration of fat into the liver but no such ill effect was observed with mustard or sesame oils when fed at the same level. Experiments with fractionated fatty acids showed that the accumulation of liver fat on low protein diets was chiefly caused by the higher saturated fatty acid (C₁₄—C₁₈).

Mineral Metabolism :

Narayana Rao and De²⁷ from metabolism experiments with rats found that excess of calcium in the diet did not influence the digestibility of low melting fats and fatty acids. However, it decreased markedly that of higher melting fats and fatty acids, the digestibility of saturated fraction of coconut oil (m. p. 52°C) being 80.03 % with excess calcium and 89.10 % on a normal intake of calcium.

Wadhwani²⁸ found that the daily administration of 20 mg. of vitamin C to monkeys receiving a basal diet plus 10 mg. of sodium fluoride per Kg. of body weight per day for 6 months, prevented the fluorosis of bones as revealed by X-ray examination. He also found that monkeys suffering from severe bone fluorosis and receiving only the basal diet when given 20 mg. of vitamin C. daily, improved considerably, and the exostoses either diminished in size or totally disappeared in 12 weeks.

26. Damodaran, M. and Siva Raman, C. (1951), Indian Jour. Med. Res., **39**, 465.

27. Narayana Rao, M. and De, S. S. (1951), *Ibid.*, **39**, 457.

28. Wadhwani, T. K. (1952), Indian Med. Gaz., **87**, 5.

FOOD TECHNOLOGY

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The main lines of work on Food Technology during the year under review relate to processing, canning, storage and preservation.

In the field of preservation of certain beans and pulses, Siddappa, Bhatia and Lal¹ carried out systematic investigations and reported that after suitable blanching first in 1% sodium bicarbonate solution and then in water for 5-10 minutes, followed by steam baking at 15 lbs. pressure for one hour, these beans could be directly packed into cans and covered with freshly prepared hot tomato sauce, containing cardamom, sugar, vinegar, etc. The cans were exhausted for 7 minutes at 185-190°F. sealed and processed at 10 lbs. pressure for 75 minutes. This work on canning of beans in tomato sauce was extended by these investigators to some of the well-known pulses and dhals which were blanched for 5 minutes and then canned in the same way as beans. Siddappa and Bhatia² took advantage of the fairly rich contents of sugar and pectin of jack fruit and standardised a method for preparing a good quality jelly. The procedure consisted in boiling the sliced fresh material with 1½ times its weight of water and 0.3% citric acid. In the first stage, where an equal volume of water was used, the boiling was gentle and lasted for 30 minutes. In the second stage, after draining away the extract, the residue was boiled for 15 minutes with the remaining quantity of water. The extract was then drained through a thick folded cloth. The combined extracts were allowed to settle, siphoned off and utilised for the preparation of jellies under different conditions. They found an extract-sugar ratio of 1 : 1 with an added acidity of 0.6-0.8% was best suited for obtaining good quality jellies.

1. Siddappa, G. S., Bhatia, B. S. and Lal, G. (1952), Bull. Central Food Tech. Res. Inst., **2**, 11.

2. Siddappa, G. S. and Bhatia, B. S. (1952), Bull. Central Food Tech. Res. Inst., **2**, 70.

Tandon³ investigated the possibilities of manufacturing pectin from the waste products of citrus squash factories. Apple pomace was leached and the pectin was extracted with 0.2% solution of citric acid or tartaric acid at 190°F. for 1-1½ hours. The extract was then clarified and treated with enzymes to decompose starch and protein. The final liquid was subsequently clarified with activated carbon and filtered. The liquid was concentrated to contain 4-4.5% pectin. Powdered pectin could be obtained either by concentrating the above liquid or by precipitating the pectin with alcohol and acetone.

Velankar⁴ suggested a simple method for the preparation of fish hydrolysate. Whole ungutted fish, about 20 cm. in length, is mixed with one-fourth its weight of salt and stored under pressure in wooden vats for several months. The hydrolysate was tapped from the bottom of the vat. About one litre of hydrolysate containing 15 gms. of total nitrogen could be obtained from 1 kg. of fish.

Rao⁵ dealt with the details of design and erection of pilot plant for the solvent extraction of oil-cakes and oil-seeds with alcohol, petrol and alcohol-petrol mixtures at temperatures varying from 150-190°F. The plant was designed to yield high grade flours suitable for edible purposes. Percentage extraction of oil as also recovery of solvent were found to be satisfactory.

Lal and Rajagopalan⁶ and Lal and De⁷ processed a cheap supplementary food possessing high nutritive value. Defatted groundnut cake flour (30%), tapioca flour (63%), and yeast (2%) were the principal constituents of the food which was spiced with salt and condiments (4%) for enhancing the palatability and taste. Carrot powder (1%) was also added to serve as a source of carotene.

Methods for the preparation of tapioca *soji* with a simple equipment were standardised at the Central Food Technological Research Institute, Mysore, and described by Swaminathan,

3. Tandon, G. L. (1952), Indian Food Packer, **6**, 9 & 25.
4. Velankar, N. I. (1952), J. Sci. and Indust. Res. India, **11B**, 310.
5. Rao, Y. K. R. (1952), *Ibid.*, **11A**, 414.
6. Lal, B. M. and Rajagopalan, R. (1952), Science and Culture, **17**, 340.
7. Lal, B. M. and De, S. S. (1952), Indian J. Physiol. and Allied Sci., **6**, 3.

Krishna and Rama Rao.⁸ Yield of the finished product was about 33% on the weight of tapioca processed. The economics of a factory with an outturn of 50 tons of products per month have been discussed. The cost of the *soji* worked out to 3.4 annas per pound.

Bains, Reddy, Bhatia and Subrahmanyam⁹ described a processing technique by which tapioca could be used like wheat flour for making *chappatis*, *puris* and vermicelli. Plain tapioca flour was found to present some difficulties in rolling up for *chappatis*, *puris*, etc., while no difficulty was encountered in the case of tapioca *soji* dough. In order to improve the handling properties of the dough, 20—30% of tapioca *soji* flour was added to plain tapioca flour. Partial gelatinisation of tapioca flour with boiling water, prior to kneading was found to improve the physical properties of the tapioca dough and make it almost similar to wheat flour dough. The authors also pointed out that the nutritive value of tapioca products could be improved by mixing the tapioca flour with 10-15% of protein rich flours of common pulses, or 5—10% of oilseed cakes.

Subrahmanyam¹⁰ discussed in a comprehensive manner the world shortage of rice with a description of the history, evolution, preparation, composition, technology, processing and cost of synthetic rice and also other aspects of the problem.

Tandon, Pruthi and Lal¹¹ made a detailed investigation into the possibilities of processing tender bamboo shoots for the production of useful articles of human food. They reported that the following products could be obtained: (i) canned shoots alone or in combination with other fruits like pine apple, orange segments etc., in syrup; (ii) canned shoots in brine; (iii) curried

8. Swaminathan, M., Krishna, B. H. and Rama Rao, G. (1952), Bull. Central Food Tech. Res. Inst., **2**, 79.

9. Bains, G. S., (Miss) Reddy, S. K., Bhatia, D. S. and Subrahmanyam, V. (1952), Bull. Central Food Tech. Res. Inst., **2**, 38.

10. Subramanyam, V. (1952), Bull. Central Food Tech. Res. Inst., **2**, 49.

11. Tandon, G. L., Pruthi, J. S. and Lal, G. (1952), Bull. Central Food Tech. Res. Inst., **1**, 301.

shoots alone or in combination with other vegetables like potatoes, tomatoes, etc.; (iv) sweet or hot chutneys; (v) pickles in vinegar, with lime and oil pickles. The hydrocyanic acid present in the shoots could be completely eliminated by steaming or boiling in two to three changes of water.

In a study of the loss of flavour from packed coffee powder, Harihara Iyer *et al*¹² examined a number of samples of the product marketed by certain firms in India. Moisture content, less of cold water extractable substances, presence of foreign matter or contaminants seemed to facilitate the development of rancidity.

The observations of Natarajan¹³ would suggest that coffee husk containing 0.2 to 0.6% caffeine was almost similar to the coffee beans except for fat and aromatic principle. The husk roasted at 230°C. could be blended with coffee in proportions varying from 5-50%. Thus, a possible use for the coffee husk in the place of chicory was indicated reducing thereby the present annual import of 10,000 cwts. of chicory. In another communication Natarajan, Kantaraj Urs, Bhatia and Anandaswamy¹⁴ reported that the natural flavour of coffee during brewing and storage was adversely affected by brass filters and suggested the use of tinned brass filters.

Kapur, Viswanatha and Mathur¹⁵ reported that cereals like wheat or rice, preserved with one part of mercury to 2000 parts of the cereals, could be stored well for about a year. Growth experiments with rats conducted with a view to determining the harmful effects, if any, of the preservative showed that the growth was normal.

12. Harihara Iyer, C. R. Rajagopalan, R., Ramaswamy, M. S. and Pillai, S. C. (1952), *Science and Culture*, **17**, 296.

13. Natarajan, C. P. (1952), *J. Sci. and Indust. Res., India*, **11A**, 410.

14. Natarajan, C. P., Kantaraj Urs, Bhatia, D. S. and Anandaswamy, B. *Indian Coffee*, **VI**, 133.

15. Kapur, N. S., Viswanatha, T. and Mathur, P. B. (1952), *Bull. Central Food Tech. Res. Inst.*, **2**, 75.

A new preservative, Gammexane, P. 520 for raw sugarcane juice was reported by Ramanayya, Manohar Rao and Raju.¹⁶ A dosage of 5 gms. of the preservative for one litre of the juice was found to be effective.

Rama Rao, Balakrishnan and Rajagopalan¹⁷ successfully spray-dried Amla (*Emblica officinalis*) juice to which 20-30% salt was added. Amla juice by itself could not be spray-dried, as the material was very sticky. Addition of salt was found to yield a product which was very fine and white. A cheap and satisfactory method of fortifying salt with vitamin C has thus been indicated by these workers.

Rama Rao, Balakrishnan and Rajagopalan¹⁸ found that by quick freezing to -20°F. certain fruits like oranges, mangoes, lemons, cashew apples, amla, etc., became very hard owing to the freezing of the juice. Consequently, the cells were killed and when the juice was extracted from these materials, yield of the juice was 15-20% more than from the unfrozen materials. As a result of getting more juice, there was a proportionate increase in the recovery of vitamin C. They suggested the possibility of applying this process, *viz.*, freezing to -20°F. to sugarcane with a view to enhancing the production of sugar in the country.

Kirpal Singh and Mathur¹⁹ carried out studies to determine the rate of ripening as also the chemical changes brought about by the process and the percentage of wastage due to decay by bacteria in two types of mangoes at 67-70°F. and 75-86°F. Ripening was found to be optimum at 67-70°F. The advantages of ripening mangoes at this temperature have been discussed.

16. Ramanayya, S. V., Manohar Rao, P. J. and Raju, K. V. (1952), *Current Science*, **21**, 279.

17. Rama Rao, P. B., Balakrishnan, S. and Rajagopalan, R. (1952), *Ibid.*, **21**, 277.

18. *Idem*, (1952), *Ibid.*, **21**, 337.

19. Kirpal Singh, K. and Mathur, P. B. (1952), *Bull. Central Food Tech. Res. Inst.*, **2**, 15.

DAIRY SCIENCE

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During the period under review many informative publications have appeared on various aspects of dairy science. The Indian Council of Agricultural Research have brought out an useful publication¹ which presents a brief description of the work done by the Council from the time of its inception in 1929 down to 1946. This gives a complete and comprehensive picture of the progress achieved not only in agriculture but also in various branches of animal husbandry and dairying. Wright² has made a general survey of some problems of tropical dairying. The progress of dairying in India during recent years has been summarised by Datar Singh,³ while Sen⁴ has presented the progress made in dairy research in India. Srivatsava⁵ has described the present position of Indian dairy industry and the role to be played by the State and private enterprises, both on an individual as well as co-operative basis in various aspects, *viz.*, feeding, breeding and management of cattle, organised production and handling of milk and milk products, training of dairy technicians and the production of dairy equipments.

A brief history of Bombay Milk Scheme, description of the farm units, milk handling plant, auxiliary equipment and services and lastly transport and distribution of milk has been presented by Brissenden.⁶ Chandrasekhar⁷ has pointed out the limited scope of the Indian Tariff Act as related to dairy machinery and the need

1. Indian Council of Agricultural Research—Agriculture and Animal Husbandry Research, 1929—46. Part II. I. C. A. R., New Delhi.

2. Wright, N. C. (1952), J. Soc. Dairy Tech., 5, 149; Indian Dairyman, 3, 175.

3. Datar Singh, (1952), Indian Dairyman, 3, 147.

4. Sen, K. C. (1952), J. Soc. Dairy Tech., 5, 115.

5. Srivatsava, K. N. (1952), Indian Dairyman, 4, 45.

6. Brissenden, C. H. (1952), J. Soc. Dairy Tech., 5, 108.

7. Chandrasekhar, C. V. (1952), Indian Dairyman, 4, 83.

for the standardisation of equipments, devising of suitable detergents, fabrication of spare parts in India and proper dairy planning for the progress of dairy industry. The same author^{8,9} has discussed the various factors involved in the selection of suitable milk pasteurising plants for dairies, advantages of H. T. S. T. method of processing milk, checking the quality of milk during and after processing as well as other aspects of pasteurisation.

1. ANIMAL HUSBANDRY

Breeds and breeding:

Agarwala¹⁰ made some suggestions for modifying Key Village block scheme for artificial insemination of cattle. Datta¹¹ discussed the role of genetics in the breeding of a prosperous livestock industry in India. Nair¹² suggested ways of improving some south Indian breeds of cattle by genetic methods. Narayanan¹³ pointed out the dearth of adequate number of sires and emphasised the need for raising more of right type of sires by selection on the basis of personality, pedigree and progeny performance. Chandiramani¹⁴ discussed the short-sighted policy of urban dairyman, the conditions which limit the breeding of better animals and the importance of selection in the breeding of animals. Desai¹⁵ suggested that cattle survey work should be carried out for each tract, and the cattle improvement work should be related to the need for each tract with definite programme of work.

Artificial insemination:

Desai¹⁶ emphasised the importance of the use of tested bulls in artificial insemination work. Veeramani Iyer¹⁷ reported the results of semen characteristics of over 600 collections from about

8. Chandrasekhar, C. V. (1952), *Indian Dairyman*, **3**, 141.
9. *Idem*, (1952), *Ibid.*, **4**, 11.
10. Agarwala, O. P. (1952), *Allahabad Farmer*, **26**, 53.
11. Datta, S. (1952), *Rural India*, **15**, 4.
12. Nair, K. S. (1952), *Indian Vet. J.*, **28**, 320.
13. Narayanan, T. (1952), *Indian Dairyman*, **3**, 116.
14. Chandiramani, T. (1952), *Ibid.*, **4**, 75.
15. Desai, H. M. (1952), *Rural India*, **15**, 85.
16. Desai, H. M. (1952), *Ibid.*, **15**, 85.
17. Veeramani Iyer, R. (1952), *Indian Vet. J.*, **29**, 43.

20 bulls of different breeds, *viz.*, Red-Sindhi, Ongole, Ayrshire, Holstein-Freisian and Murrah. Prabhu and Bhattacharya¹⁸ analysed over 100 pairs of ejaculates collected in rapid succession at weekly intervals from buffalo bulls for the usual semen characteristics and reaction time and concluded that the second ejaculate obtained at weekly intervals was a better sample for routine use. Some work on the artificial insemination in sheep and goats was also carried out by Guha, Kohli and Bhattacharya¹⁹, and Desai and Winters^{20,21}. Krishna Rao²² used 1.0% aqueous mercurochrome successfully for staining semen smears.

Cross breeding for milk production:

Agarwala²³ presented the work carried out in important research centres in United States on the cross breeding of the Zebu with *Bos taurus*, and also the actual first lactation production records of the Red Sindhi X Jersey cross breeds maintained at the Beltsville Research Station. Krishna Rao²⁴ suggested the need for further research on cross breeding of Indian cattle with Jersey as a solution for increasing the level of milk production. Maule²⁵ has given an execellent account of the results of experimental breeding of dairy cattle for hot climates particularly in India, Ceylon, Philippines and West Indies. In all these places cross breeding between Zebu (*Bos indicus*) and European breeds (*Bos taurus*) was attempted. The author recommended Jersey as the most suitable European breed for crossing and amongst the Zebu breeds, the Red-Sindhi. He emphasised that the new type should at first be confined to special areas and to chosen breeders. Since cross breeding could only succeed on a very limited scale

18. Prabhu, S. S. and Bhattacharya, P. (1951), Indian J. Vet. Sci., **21**, 257.

19. Guha, S., Kohli, M. L. and Bhattacharya, P. (1952), *Ibid.*, **21**, 171.

20. Desai, R. N. and Winters, L. M. (1951), *Ibid.*, **21** 177.

21. Desai, R. N. and Winters, L. M. (1951), *Ibid.*, **21**, 191.

22. Krishna Rao, C. (1952), Indian Vet. J., **28**, 423.

23. Agarwala, O. P. (1952), Allahabad Farmer, **26**, 68.

24. Krisbna Rao, C. (1951-52), Madras Vet. College Annual, **10**, 23.

25. Maule, J. P. (1952), Indian Vet. J., **28**, 408; Indian Dairyman, **3**, 155.

and in particular environments, Maule²⁶ in another article discussed the main problems of improving the milk yield of the cattle population in India as a whole. Selection for high yield without affecting the draft qualities of the bullocks, feeding and management of cows and young female stock, selection of several superior milking strains of the 'dairy breeds' (Murrah, Red Sindhi, Gir, and Ongole in South and Central India) with the object of using bulls of these breeds for crossing with inferior and ill-defined types in certain regions would form the main considerations. The adaptability of cattle to tropical and sub-tropical climates with special reference to milk production was studied by the Food and Agriculture Organisation.²⁷

Management of cattle:

A statistical study of the first lactation records of Red-Sindhi and Kangayam herds maintained at the Livestock Research Station, Hosur, was made by Rajagopalan.²⁸ The average birth weight of the calf, weight of the animal at first calving and milk yield of the first lactation were 43.9, 551.5 and 3,389.5 lb., respectively, for the Red-Sindhi breed. The corresponding figures for Kangayam breed were 45.1, 590.2 and 1,413.1 lb., respectively. The age of Red-Sindhi and Kangayam heifers at first calving were 1,331 and 1,448 days, respectively. Lazarus and Anantakrishnan²⁹ studied the influence of the sex of the calf, breed, calving sequence, weaning of the calf at birth and the month of calving on the length of gestation of Red-Sindhi, Gir and cross bred cows. Red-Sindhi, Gir and cross bred calves were carried *in utero* for 283.0, 285.1 and 280.0 days, respectively. Bull calves were carried for a longer period than heifer calves in all the breeds. The calving sequence and the month of calving had no influence on the gestation period. Similar studies on the gestation period of Tharparker cattle

26. Maule, J. P. (1952), Indian Dairyman, **4**, 21.

27. F.A.O. Agricultural Studies, No. 1. Breeding livestock adapted to unfavourable environments, Indian Dairyman, (1952), **4**, 5.

28. Rajagopalan, V. R. (1952), Indian Vet. J., **28**, 293.

29. Lazarus, A. J. and Anantakrishnan, C. P. (1952), Indian J. Dairy Sci., **5**, 9.

maintained at Government Cattle Farm, Patna, were made by Choudhuri and Sinha.³⁰ The mean gestation period of 1,146 calvings was 287.15 days. The average gestation period for male calves was 288.50 days and that for females 285.80 days. The gestation period increased with the age of the cow up to the 7th calving and after that the tendency was for a shorter gestation period. The mean birth weight of male calves was 48.7 lb. and that of female calves 47.5 lb. Anantakrishnan, Lazarus and Rangaswamy³¹ reported that the sire of the calf had a significant influence on the gestation period of Red-Sindhi, Gir, Tharparker, Haryana and Sahiwal cows. They also found that the introduction of an Ayrshire bull in these indigenous breeds caused a significant shortening in the gestation period for their cross bred calves. Further, this effect of the breed of the bull was noticed in $\frac{1}{2}$ Ayrshire X Red-Sindhi as well as $\frac{1}{2}$ Ayrshire X Red-Sindhi cows. Some work was carried out on the gestation period and the birth weight of Murrah buffaloes by Arunachalam, Lazarus and Anantakrishnan.³² The average gestation period for Murrah buffaloes was 305.3 days and the average birth weight of calves 73.2 lb. The sex of the calf and the month of freshening had no influence on either gestation period or the birth weight of calves. The sire of the calf as well as calving sequence influenced the birth weight but not the gestation period. The correlation coefficient between the birth weight and the weight of the dam was +0.415 (statistically significant).

From a study of the records of University of Nebraska dairy herd, Plum, Singh and Schultze³³ found a positive correlation (+0.34) between the rate of growth in heart girth between the ages of 10 to 12 months and the most probable producing ability. Growth rate in heart girth at this age was

30. Choudhuri, A. C. and Sinha, C. (1951), Indian J. Vet. Sci., **21**, 69.

31. Arantakrishnan, C. P., Lazarus, A. J. and Rangaswamy, M. C. (1952), Indian J. Dairy, Sci., **5**, 63.

32. Arunachalam, T. V., Lazarus, A. J. and Anantakrishnan, C. P. (1952), *Ibid.*, **5**, 117.

33. Plum, M., Singh, B. N. and Schultze, A. B. (1952), J. Dairy Sci., **35**, 957.

suggested to be of some help in evaluating future butterfat production of the individual.

Pal³⁴ studied the morning and evening body temperature of buffalo stock in summer and found that animals other than calves under one year did not show much variation from the normal body temperature. During summer, the overall mean temperature for calves under one year was 101.6°F and 102.4°F for morning and evening, respectively; the corresponding figures for winter were 100.9 and 101.8°F. The author concluded that particularly calves under one year of age lacked the ability to lose their body heat freely and hence suffered bodily inconvenience.

Manradiar³⁵ described the indications in a pregnant cow which were suggestive of twin births. Sunder Singh³⁶ gave an account of the different laboratory methods in the diagnosis of pregnancy. Wilson³⁷ reported a new method, from the experience of a dozen cases, for dehorning adult cattle. The main advantages were that it limited haemorrhage and the after treatment. It also reduced the infection of the sinuses and the stump got covered up by the skin in due course. Narayanan³⁸ stressed the need for dehorning cattle and suggested the methods adopted for the same.

DISEASES IN CATTLE

(a) Contagious abortion:

Krishna Rao³⁹ studied the effect of the incidence of contagious abortion on fertility in cows, the effect of abortion on the number of services required for conception and the effect of age on fertility. The authour found that mere occurrence of the disease did not lower the herd fertility in a striking manner. High herd fertility could be maintained in a particularly Brucella-infected herd having cows with high reproductive efficiency under conditions of good management. More number of services were also required

34. Pal, R. D. (1952), Indian Vet. J., **29**, 210.

35. Manradiar, N. N. S. (1952), Indian Dairyman, **3**, 100.

36. Sunder Singh, S. V. (1951-52), Madras Vet. College Annual, **10**, 3.

37. Wilson, F. D. (1952), Indian Vet. J., **29**, 49.

38. Narayanan, D. (1952), Indian Dairyman, **4**, 55.

39. Krishna Rao, C. (1951), Indian J. Vet. Sci., **21**, 81.

for conception following abortion than after normal calving. The reproductive efficiency was low in heifers and this improved with age at least as far as the first 3 conceptions were concerned.

The degree of sensitivity to streptomycin on certain gram negative organisms of pathogenic importance was studied by Choudhury⁴⁰ on dextrose-agar media. *B. abortus* was more sensitive than *E. Coli* and its growth was most affected even with the highest dilution of streptomycin. *Shig. gallinarum*, *Shig. dysenteria*, *E. typhosa* and *Sal. typhimurium* showed their sensitivity to streptomycin to a less extent than *E. Coli* and their degree of sensitivity was observed to be on the decline in the order mentioned. *Alc. bronchisepticus* gave no response to streptomycin even in dilution of 100 μ g./ml. of dextrose-agar base.

(b) Foot and Mouth disease :

The annual loss on account of Foot and Mouth disease has been estimated by Minnet⁴¹ at Rs. 5,200,000 or Rs. 17,000 per 100,000 of a cattle population, 17% of which are buffaloes. Mathur⁴² presented the economic importance, symptoms, spread, control and treatment of Foot and Mouth disease in cattle. In an investigation to evolve a suitable vaccine for protecting the Indian cattle against this disease Seetharaman and Datt⁴³ reported the occurrence of all the 3 known strains. The percentage of incidence of the strains, viz., 'O', 'A' and 'C' and their variants were 59.6, 27.4 and 11.3, respectively. Besides these, an atypical strain of the virus was also isolated by these workers and the percentage of incidence of this was 1.6.

(c) Anthrax :

Minnet⁴⁴ studied the sporulation and viability of *B. anthracis* in relation to environmental temperature and humidity and found that the bacillus survived for a long time in the bone marrow, skin of animals dead of anthrax and also in dry soil. Rajagopalan and

40. Choudhury, B. (1952), Indian Vet. J., **29**, 34.

41. Minnet, F. C. (1952), Emp. J. Exp. Agri., 1952, **20**, 77; Indian Vet. J., **29**, 1.

42. Mathur, A. C. (1952), Indian Farming, **2** (5), 18.

43. Seetharaman, C. and Datt, N. S. (1951), Indian J. Vet. Sci., **21**, 251.

44. Minet, F. C. (1952), Indian Vet. J., **28**, 325.

Israel⁴⁵ isolated avirulent immunising variants from virulent anthrax strains by growing the strains on 50% horse serum agar in 20% CO₂ according to Sterne's technique. They found that the vaccines made from one such isolated variant was satisfactory for use in Indian cattle, sheep and goats. The vaccine immunised practically all animals in 6 days. A dose of 30,000 spores gave good immunity and one million very solid immunity in goat and sheep. At a temperature below 10°C the vaccine retained its strength and immunising property up to 6 months and at 0°C even up to 15 months. Vaccinated animals were found to retain a good grade of immunity up to one year.

(d) Black Quarter :

Vancheswara Iyer⁴⁶ in an investigation of the organisms responsible for outbreaks of Black Quarter in Madras State reported that out of 30 specimens of muscles from Black Quarter cases received, *Cl. chauvoei* was isolated from 26 specimens, *Cl. septique* from 3 specimens and a mixture of these two from 3 specimens. *Cl. welchii* was not met with in the above specimens.

(e) Pneumonia :

Gopalakrishnan⁴⁷ made a regional survey of the distribution and seasonal incidence of bovine contagious pleuro pneumonia in Assam during the years 1940 to 1949. The distribution of this disease was widespread in the Brahmaputra valley of Assam. It had no periodicity or regularity in its occurrence and was reported to be due to the unrestricted cattle movement and not related to the climatic conditions. In vaccinated locality no outbreak was reported for a period of 5 years.

(f) Tuberculosis :

Saroop⁴⁸ presented the results of a double intra dermal Tuberculin test carried out in Gaushala herd, Agroha (Hissar district). The author found that cattle in apparent sound health were

45. Rajgopalan, V. R. and Israel, M. (1952), Indian Vet. J., **29**, 171.

46. Vancheswara Iyer, S. (1952), *Ibid.*, **29**, 27.

47. Gopalakrishnan, V. R. (1951), Indian J. Vet. Sci., **21**, 215.

48. Saroop, H. H. (1952), Indian Vet. J., **29**, 47.

positive to this test. All male calves were negative to the test while 20% of the female calves were positive to it.

(g) Mastitis :

Narayanan⁴⁹ described the economic importance, forms, causes, spread, control and treatment of mastitis in cattle. Azizuddin⁵⁰ gave an account of the bacteriology, pathology and control of this disease on an all India basis.

The effectiveness of ten proprietary insecticides in varying dilutions on house flies, goat lice, buffalo lice and cattle ticks was tried by Balarama Menon, Sen Gupta and Basu.⁵¹ "Gamatox" paste dip in a dilution of 1 in 20 was effective against buffalo ticks. "Neocid" dusted into the hairs of animals controlled buffalo lice and cattle ticks in 24 hours. "Geigy 1050" when sprayed in a 5% suspension in water controlled cattle ticks with no reinfestation in 15 days.

2. MILK

Physical properties :

In connection with a survey on the freezing point of milk in different parts of India, Venkateswara Rao, Dastur and Dharmarajan⁵² used various preservatives and found that $HgCl_2$ in a concentration of 0.075% was a good preservative for keeping samples of milk for a fortnight. The average increase in the freezing point depression brought about by the addition of 0.075% $HgCl_2$ was $0.02^{\circ}C$. Ramakrishnan and Banerjee⁵³ reported a simple and quick method of determining the refractive index of milk, in contradistinction to that of milk serum with the use of Abbe's refractometer. They analysed nearly 17,000 samples of cow and buffalo milk from different parts of India and determined the effect of feed, acidity, processing, and addition of skim milk, water and sucrose to milk. Samples of milk obtained from August to December gave higher values for refractive index than samples

49. Narayanan, T. (1952), Indian Dairyman, **4**, 91.

50. Azizuddin, I. M. (1952), Madras Vet. College Annual, **10**, 33.

51. Balarama Menon, P., Sen Gupta, C. M. and Basu, B. C. (1951), Indian J. Vet. Sci., **21**, 215.

52. Venkateswara Rao, R., Dastur, N. N. and Dharmarajan, C. S. (1950), Indian J. Vet. Sci., **20**, 263.

53. Ramakrishnan, C. V. and Banerjee, B. N. (1952), Indian J. Dairy Sci., **5**, 25.

collected in other months. The refractive index was higher when animals were fed cotton seed cake than when they were fed grass alone. Developed acidity and processing increased the refractive index. Addition of water or skim milk lowered the refractive index. Puri, Lakhapal and Gupta⁵⁴ verified Stoke's law in the case of the rise of fat globules in milk and applied the same for the determination of size distribution of fat globules in the milk of different species of animals. For the fractions of fat globules a micro-pipette technique by means of which thin sections of the sedimenting fluid could be withdrawn from extremely small depths was employed. Buffalo milk was found to contain the coarsest and goat milk the finest globule size which was not variable as the composition of milk, and appeared to be independent of fat content of milk, other factors being the same. The author suggested the possibility of using this method for the differentiation of the milk of different species of animals.

Chemical properties :

Puri and Singh⁵⁵ developed a simple method for the routine estimation of lactose in milk based on its oxidation by acidified KMnO_4 solution. They analysed a number of milk samples obtained from different sources and showed that their results were quite in agreement with the results obtained by Pavy's method.

Shaffy *et al*⁵⁶ studied the effect of ration and the stage of lactation on the total protein, casein and non-protein nitrogen in the milk of the sow. The additions of vitamin B_{12} and animal proteins made no changes in the total protein and casein contents of the colostrum of sows previously maintained on a corn, soya bean meal and 52% alfalfa ration. The total protein and casein contents dropped from colostrum to 15 days milk, but rose slightly in 30 days milk. The non-protein nitrogen content increased significantly from colostrum to 15 days milk and there was a further increase in 30 days milk.

54. Puri, B. R., Lakhapal, M. L. and Gupta, S. C. (1952), Indian J. Dairy Sci., **5**, 189.

55. Puri, B. R. and Singh, B. (1952), Indian J. Dairy Sci., **5**, 39.

56. Shaffy, B. E., Shahani, K. M., Grummer, R. H., Phillips, P. H. and Sommer, H. H. (1952), J. Nutrition, **48**, 103.

The N. P. N. constituents of milk of cows, buffaloes, goats and sheep were studied in great detail by Venkatappaiah and Basu.⁵⁷ Under identical conditions of feeding, the concentrations of the N. P. N. constituents of the milk of different breeds of cows did not vary. Sheep milk was rich in N. P. N. and amino acid N contents. Goat milk contained nearly double the amount of urea N as compared with cow milk. The uric acid content of cow milk was much higher than the milk of other species of animals. The creatinine content of buffalo and sheep milk was relatively high. The season of the year and the stage of lactation were found to have no influence on the concentration of the N. P. N. constituents of milk. Colostrum contained higher amounts of N. P. N. constituents, except creatinine, than normal milk.

Lily, Kannan and Basu⁵⁸ determined the cholesterol content of the milk from individual cows and buffaloes. The cholesterol content varied from 1 to 5 mg. and 1 to 8 mg/100 ml. in the milk of cows and buffaloes, respectively. The cholesterol values were higher in milk towards the end of lactation, but season of the year had no effect on the concentration of this constituent. The cholesterol content was practically the same in the milk of different indigenous breeds of cows. The values for the milk from cross bred cows were higher than those of indigenous breeds.

Chanda, McNaught and Owen⁵⁹ studied the effect of thyroxine and thiouracil on the partition of aneurin in relation to changes in the phosphatase titre of milk. The simultaneous changes produced in the concentration of some of the major constituents of milk and in the concentrations of certain minerals and water soluble vitamins were also followed. Chanda and Owen⁶⁰ found that phosphatase was correlated positively with inorganic P and negatively with ester and lipid P in colostrum and milk of cows.

Chanda and Owen⁶¹ reported that goat milk contained 142 I. U. of vitamin A/100 ml., all of it being in the ester form; cow

57. Venkatappaiah, D. and Basu, K. P. (1952), Indian J. Dairy Sci., **5**, 95.

58. Lily, G. S., Kannan, A. and Basu, K. P. (1952), Indian J. Dairy Sci., **5**, 125.

59. Chanda, R., McNaught, M. L. and Owen, E. C. (1951), Biochem. J., **51**, 543.

60. Chanda, R. and Owen, E. C. (1952), *Ibid.*, **51**, iii.

61. Chanda, R. and Owen, E. C. (1952), Biochem. J., **51**, 404.

milk had 88 I. U. of vitamin A, 6% of which was in the alcohol form. The orange to yellow colour of the colostrum of goats were identified as β carotene as well as lipochrome by Chanda and Owen.⁶² The amount of β carotene varied from 12 to 46 microgram/100 ml. of colostrum of goats. The effect of thyrotrophin on the vitamin A and carotenoids content in the milk of cow was found to be similar to that of thyroxine by Chanda and coworkers.⁶³ Chanda⁶⁴ also reported that in cow milk 5 to 8 I.U. of vitamin A in alcohol form per 100 ml. were always present and this amount was unaffected by the stage of lactation. Goat milk contained 60 I.U. of vitamin A/g. of fat in the second week of lactation and the corresponding value for cow milk was 49 I.U. Information on the vitamin A content of the buffalo colostrum was made available for the first time. Narayanan, Paul, Anantakrishnan and Sen⁶⁵ from an analysis of the colostrum from 26 buffaloes reported the highest value of 308 I.U. of vitamin A per g. for the first postpartal fat. Compared to cow colostral fat the vitamin A values for the buffalo colostral fat appeared to be rather low.

Nandi, Rajagopalan and De⁶⁶ compared the supplementary value of a "vegetable milk" processed in their laboratories with cow milk to a poor rice diet by human experiments with growing children. The results indicated that supplementation of both the milks was beneficial and the percentage retention of N, Ca and P with "vegetable milk" supplementation was comparable with cow milk supplementation.

Bacteriology of milk :

Laxminarayana and Iya⁶⁷ indicated the usefulness of tetrazolium bromide as a valuable tool for taxonomical studies for

- 62. Chanda, R. and Owen, E. C. (1952), *Ibid.*, **51**, iv.
- 63. Chanda, R., Clapham, H. M. and Owen, E. C. (1952), *Ibid.*, **52**, xvii.
- 64. Chanda, R. (1952), *Ibid.*, **52**, ii.
- 65. Narayanan, K. M., Paul, T. M., Anantakrishnan, C. P. and Sen, K. C. (1952), *Indian J. Dairy Sci.*, **5**, 45.
- 66. Nandi, D. K., Rajagopalan, R. and De, S. S. (1952), *Science and Culture*, **18**, 199.
- 67. Laxminarayana, H. and Iya, K. K. (1952), *Science and Culture*, **18**, 124.

finding the nutritional requirements of different organisms, for microbiological assay of vitamins and amino acids and also for quality control work. Nambudripad, Laxminarayana and Iya⁶⁸ carried out investigations on the use of hydrogen peroxide for preservation of milk. The authors found that hygienically produced raw milk could be kept in good condition at room temperature for 48 to 80 hours by the addition of 300 p.p.m. of H_2O_2 . Pasteurisation of milk before and after the addition of H_2O_2 increased the keeping quality of good and fair quality milk at 30°C to 120-138 hours. Riboflavin, niacin, thiamine and vitamin B₁₂ were not affected by the H_2O_2 cum heat processing of milk. The preserved milk was satisfactorily utilised for the preparation of *dahi* or butter. Need for careful supervision and technical control of the process for long distance transport of milk was emphasised by the authors. Sreenivasamurthy and Iya⁶⁹ described a microbiological assay procedure for the determination of riboflavin in dairy products using a strain of *L. bacillus plantarum* as test organism and compared the results with those obtained by using *L. casei*. The authors found that *L. plantarum* 89 compared favourably well with *L. casei* in giving a linear response to graded doses of riboflavin and in having a wide range of sensitivity. Further, *L. plantarum* produced higher total acidity at the assay levels and was less susceptible to the influence of fat and proteins in milk.

3. MILK PRODUCTS

Ghee :

The problem of finding out suitable indicator substances which may be added to *Vanaspati* so that the presence of the latter can be detected if used to adulterate fats is of considerable importance in India where adulteration of ghee with *Vanaspati* is practised on a large scale. Subrahmanyam and coworkers⁷⁰ discussed the problem of adulteration of ghee and its detection. Gulati and

68. Nambudripad, V. K. N., Laxminarayana, H. and Iya, K.K. (1952), Indian J. Dairy Sci., 5, 135.

69. Sreenivasamurthy, V. and Iya, K. K. (1952), Indian J. Dairy Sci., 5, 53.

70. Subrahmanyam, V. Srinivasan, M. and Bhalerao, V. R. (1952), J. Sci. Ind. Res. India, 11A, 277.

Kartha⁷¹ reported the use of ethyl ester of tyrosine as an indicator substance for the detection of *Vanaspati* when used as an adulterant of ghee. Bhide and Kane⁷² determined the critical temperatures of dissolution (CTD) of a number of samples of genuine ghee, bazaar ghee and *Vanaspati*. Ghee and *Vanaspati* were reported to have their distinct ranges 39-45°C and 62-72°C, respectively. This method has been suggested to detect and estimate gross adulteration of ghee with *Vanaspati*. However CTD values were lower for high acid and rancid samples of ghee and *Vanaspati*. Hence some allowance had be made wherever these defects were prominent.

Using pancreatic lipase, Bhalerao, Venkatappaiah and Anantakrishnan⁷³ carried out *in vitro* digestion studies of butter fats and body fats of cow, buffalo, goat and sheep, the edible oils and hydrogenated fats of different melting points. The authors reported that the butter fats were digested at a higher rate than the body fats of the same mammals and the hydrogenated oils of vegetable origin. Butter fat from different species were digested at almost the same rate. There was not much difference in the digestibility of different oils except coconut oil which was found to have the same digestibility as butter fat. Hydrogenation lowered the digestibility of oils. The same authors⁷⁴ also carried out metabolic experiments on adult rats at 5% level and confirmed the results of *in vitro* digestion studies.

Dahi :

Some information regarding the changes in the vitamin content of milk during its souring and conversion into *dahi* were reported by Rao and Basu.⁷⁵ They observed that the use of mixed cultures consisting of *Lactobacillus bulgaricus* and *Streptococcus*

71. Gulati, K. C. and Kartha, A.R.S. (1952), *Ibid.*, **11B**, 346.

72. Bhide, P. T. and Kane, J. G. (1952), *Indian J. Dairy Sci.*, **5**, 183.

73. Bhalerao, V. R., Venkatappaiah, D. and Anantakrishnan, C. P. (1950), *Indian J. Vet. Sci.*, **20**, 271.

74. Paul, T. M., Bhalerao, V. R. and Anantakrishnan, C. P. (1951), *Ibid.*, **21**, 1.

75. Venkateswara Rao, R. and Basu, K. P. (1952), *Indian J. Dairy Sci.*, **5**, 1.

paracitrovorous for *dahi* making led to the partial destruction of thiamine, riboflavin and niacin, the extent of destruction being practically the same for curd from the milk of cows, buffaloes, goats and sheep. Curds were also made by using pure single cultures of *L. bulgaricus*, *L. acidophilus*, *L. casei*, *S. cremoris* and *S. lactis*. All the above mentioned single cultures were found to utilise niacin for their growth. Two organisms, viz., *S. cremoris* and *S. lactis* synthesised thiamine during curd formation, the amount varying from 7.5 to 35.4% over that present in milk by using *S. lactis*, and from 14.0 to 50.0% by using *S. cremoris*. All organisms, except *S. cremoris* seemed to destroy riboflavin. Anantaramiah and Iya⁷⁶ examined the possibility of utilising cow and buffalo colostrum for *dahi* making. It was found that heat treatment of colostrum at a few degrees below the pre-determined coagulation temperatures, which ranged from 66 to 86°C, reduced effectively the initial contamination without affecting the stability of the proteins. Use of a combination of organisms comprising *S. lactis*, *S. thermophilus*, *S. faecalis*, *L. bulgaricus* and *L. plantarum* resulted in a *dahi* of good texture and flavour. Balakrishnan and Rajagopalan⁷⁷ in their studies on the influence of supplementation of milk and curd on the intestinal synthesis of thiamine in rats found that the excretion of thiamine by the rats receiving curd in their diet was higher than in the group getting milk. They suggested that the increased excretion of thiamine by the curd group was due to increased intestinal synthesis.

Khoa :

De and Ray^{78,79} carried out systematic studies to find out the effect produced by the conditions of dehydration and the type of milk used on the quality and yield of *khoa*. The average yield of *khoa* from cow milk was 18.3% containing 25.3% moisture, whereas with buffalo milk the average yields were 21.6% with 21.8%. The

76. Anantaramiah, S. N. and Iya, K. K. (1952), *Ibid.*, **5**, 33.

77. Balakrishnan, S. and Rajagopalan, R. (1952), *Current Science*, **21**, 135.

78. De, S. and Ray, S. C. (1952), *Indian J. Dairy, Sci.*, **5**, 147.

79. Ray, S. C. and De, S. (1952), *Indian Dairyman*, **4**, 27.

ratio of concentration at *pat* formation was 5.39 and 4.51 for cow and buffalo milk, respectively. *Khoa* prepared from buffalo milk was found to possess desirable marketable qualities. Level of fat and the ratio of SNF/fat in milk influenced both the yield and the moisture content of *khoa*. From their results the authors concluded that market *khoa* should have a moisture not more than 27%; fat, protein, lactose and ash not less than 33, 20, 24, and 4%, respectively, and iron content not more than 160 p.p.m.

Other milk products:

Ray⁸⁰ suggested the need for exploring the possibilities of the manufacture of condensed milk and dried milk in India, particularly for the Armed Forces. Whitney, Paulson and Murthy⁸¹ devised a test for measuring the heat stability of proteins in a milk sample suitable for research purposes. Herreid *et al*⁸² studied the effect of heating cream at 170° to 300°F in 10° intervals in a small tube heat exchanger (Malloriser) on fat globule size, viscosity, pH, titratable acidity, flavour and stability in coffee.

Bhat and coworkers⁸³ prepared milk powder under laboratory conditions. Eighteen aerobically growing bacteria and 3 molds were recognised as occurring in milk powder besides the anaerobic *Clostridium perfringens*, an organism of faecal origin. The 3 isolates of molds were identical with those very species of *Aspergillus*, *Penicillium* and *glibotrys* encountered before among the flora of ghee.

Ray and Srinivasan⁸⁴ gave an account of the various ways of utilising separated milk for edible and industrial products. Anantakrishnan and Badami⁸⁵ suggested the possibilities of

80. Ray, S. C. (1952), Indian Dairyman, **3**, 104.

81. Whitney, R. M., Paulson, K. and Murthy, G. K. (1952), J. Dairy Sci., **35**, 937.

82. Herreid, E. O., Shahani, K. M., Dupuy, C. J. and Tracy, P. H. (1952), J. Dairy Sci., **35**, 13.

83. Bhat, J. V., Sethana, K. and Balsekar, N. (1951), J. Univ. Bombay, **20B**, 35.

84. Ray, S. C. and Srinivasan, M. R. (1952), Indian Dairyman, **3**, 181.

85. Anantakrishnan, C. P. and Badami, M. C. (1952), Indian Dairyman, **3**, 89.

preparing casein from butter-milk. Mitra⁸⁶ developed a rapid method for the determination of fat in *chhana* which is in principle similar to that followed for the determination of fat in soft curd cheese. De⁸⁷ described the composition, method of preparing the mix, processing, ageing, freezing, packaging and marketing of ice cream.

86. Mitra, S. N. (1952), *Science and Culture*, **18**, 150.

87. De, S. (1952), *Indian Dairyman*, **4**, 65.

Other References

88. Progress of Bombay Milk Scheme (1952), *Indian Dairyman*, **4**, 4.
89. Milk Supply in West Bengal (1952), *Indian Dairyman*, **3**, 91.
90. Technical assistance to India in the sphere of animal production under the expanded assistance programme of F. A. O., Daubney, R. (1952), *Indian Vet. J.*, **29**, 167.
91. Report of the department of animal husbandry and dairying for 1951-52. Warner, J. N. (1952), *Allahabad Farmer*, **26**, 140.
92. Eleventh All-India Cattle Show, Dhingra, S. L. (1952), *Indian Farming*, **2**, (3), 16.
93. Gopabhatami day, President's broadcast (1952), *Indian Vet. J.*, **29**, 231.
94. The nature of yeast stimulating agent in mammalian spermatoza, Ghosh, D. and Lardy, H. A. (1952), *J. Ani. Sci.*, **11**, 545.
95. Bovine Haematuria. Datta, S. (1952), *Indian Vet. J.*, **29**, 187.
96. Studies on some minor constituents of milk. Lily, G. S. (1952), M. Sc., thesis of the Bombay University.
97. Studies on the keeping quality of butter and ghee and colour development in ghee. Lalita, K. R. (1952), M. Sc. thesis of the Bombay University.
98. Studies on lactic acid bacteria with special reference to their dye reduction capacity. Laxminarayana, H. (1952), Ph.D. thesis of the Bombay University.
99. Biochemical studies on lactic acid bacteria-diacetyl production. Anantaramiah, S. N. (1952), M. Sc. thesis of the Bombay University.
100. Studies on the utilisation of dairy bye-products. Badami, M. C. (1952), M. Sc. thesis of the Bombay University.
101. Studies on some technological aspects of ghee manufacture. Mani, G. S. (1952), M. Sc. thesis of the Bombay University.
102. Studies on the dessication and coagulation of milk in the manufacture and storage of indigenous milk products. De, S. (1952), M. Sc. thesis of the Bombay University.

HUMAN PATHOLOGY

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In the following pages an attempt has been made to review all the available literature published during the year. For convenience, the papers have been classified under eight broad divisions.

I. NEW GROWTHS

Mangalik and Misra¹ made a review of 26 cases of resection of bowels. The histological examination revealed 6 of them to be neoplastic conditions of the intestines (2 primary lymphosarcoma of the ileum and 4 carcinoma of the ileum and caecum). In the remaining 20 cases the lesions were confined to the terminal ileum and caecum and presented a gross picture of chronic granulomatous mass with thickening of the proximal ileum. In some, the mucous membrane was ulcerated and necrotic, in others small polypoid projections on the mucous surface were visible. The degree of stenosis at the ileo caecal junction and the thickening and fibrosis of the adjacent bowel wall were variable. In four cases, small nodules of yellowish white colour were seen on the bowel wall. In some, few enlarged lymph glands were seen along the border of the intestinal loops. These were firm and the cut surface showed no caseation. On histological examination, the common pattern had been one of diffuse granulomatous process consisting of the crowding of the various coats of intestinal walls with lymphocytes, plasma cells, monocytes and eosinophils and a variable degree of fibroblastic proliferation and fibrosis. Necrosis of mucous membrane was common. In all specimens a focal collection of cells presenting the appearance of a "tubercle" with foreign body type of giant cells was noticed. Caseation was however strikingly absent and acid fast bacilli could not be demonstrated. In view of the findings the authors have doubted the condition to be tuberculous and they advise not to label them as "primary intestinal tuberculosis."

1. Mangalik, V. S. and Misra, S. C. (1952), J. Indian Med. Assoc., 22, 12.

Kothare² reported a case of adeno-acanthoma arising in the pyloric portion of the stomach in a male aged 50 years. The tumour measured $6 \times 5 \times 5$ cm. and its central portion was necrosed, forming a crateriform ulcer. The neoplasm was composed of greyish white homogeneous tissue and had infiltrated the wall of the stomach and formed an ovoid mass on its serosa. On section, the neoplastic cells were seen infiltrating the submucosa and the deeper tissues. They were in sheets and cords of various sizes with scanty stroma in between. Some of the cells were columnar and others squamous. The nucleus showed marked variation in size and chromatin content and some of them possessed prominent nucleoli. Epithelial pearls were seen at places and keratinization was a prominent feature. At places the neoplasm had infiltrated diffusely the muscular and the subserous coats with typical pattern of adenocarcinoma. At other places there were sheets of neoplastic cells, spheroidal and polyhedral in structure.

Chitkara and Goyle³ described a case of *pseudomyxoma peritonii*, being secondary to mucocele of the appendix. At *post mortem* examination, large amount of haemorrhagic, gelatinous fluid was found in the abdominal cavity which also presented masses of varying sizes from a few mm. to 10 cm. in diameter. Histologically, the gelatinous masses presented cystic spaces of varying sizes, containing structureless mucoid material. The tissue between the cysts was myxomatous in appearance.

Nanavati⁴ presented a clinico-pathologic study of 18 cases of rhabdomyosarcoma, four of which arose from the tongue and 5 from the mouth and pharynx. The mean duration of life from onset of the disease was 2 years and 2 months.

Mangalik and Mathur⁵ reported a case of plasma cell mastitis in a lactating breast. The case was clinically diagnosed as carcinoma of the breast and a radical mastectomy was performed. Diagnosis of plasma cell mastitis was made on histopathological examination. There was a large area of chronic granulation tissue

2. Kothare, S. N. (1952), Indian Med. Gaz., **87**, 105.
3. Chitkara, N. L. and Goyle, A. N. (1952), *Ibid.*, **87**, 137.
4. Nanavati, A. N. D. (1952), Indian J. Med. Sci., **6**, 775.
5. Mangalik, V. S. and Mathur, M. S. (1952), Indian Med. Gaz., **87**, 249.

with newly formed blood vessels, proliferating fibroblasts and intense accumulation of inflammatory cells. The cells were predominately plasma cells. There were also large areas of cellular collections, mostly of plasma cells. Lymphatic sinuses were dilated and filled with plasma cells. They stressed the clinical resemblance of this disease to carcinoma of the breast.

Rangam and Rangan⁶ observed one case of primary carcinoma of the fallopian tube out of 527 cases of cancers of the female genital tract diagnosed in the Madras Medical College. The case showed an anaplastic histological pattern with unusual infiltration of the tubal wall. The tumour was situated at the fimbrial end of the right fallopian tube and was of the size of a fist. A sagittal section through it revealed its friable and papilliferous character, besides haemorrhage and necrosis. The micro-section showed diffuse infiltration with chronic inflammatory cells. The most striking feature was the infiltration of the tubal wall, deep into the muscular coat, with sheets of malignant cells showing numerous mitosis but devoid of any pattern. The growth itself showed, besides the papillary and papillary-alveolar pattern, a highly anaplastic appearance. Lymphatic emboli were also seen.

Bhende⁷ reported a case of carcinoma of the renal parenchyma most conspicuous feature of which was the presence of glomerulus-like structures. None of the structures contained capillary tufts like those of normal glomeruli, but were made up of tufts of round, polyhedral and elongated cells arranged in finger-like processes around avascular cores of fibrous tissue. The structures were considered to be not true glomeruli but were formed by papilliferous proliferation of the lining cells of the neoplastic tubules and the consequent distension of the tubules producing them. The neoplasm probably originated from a pre-existent adenoma. Bhende⁸ also described 4 cases of plain muscle tumour of the kidney with an unusual histological structure. The tumours showed a characteristic angiomatous pattern produced by arterioles,

6. Rangam, C. M. and Rangan, S. (1952), Indian Med. Gaz., **87**, 3.

7. Bhende, Y. M. (1952), *Ibid.*, **87**, 44.

8. Bhende, Y. M. (1952), Indian J. Med. Sci., **6**, 747.

and the cells of the muscular walls of arterioles were seen to pass insensibly into the surrounding tumour cells. The same author⁹ described a rare condition, *viz.*, the simultaneous development of two independent malignant neoplasms in the same organ.

Sirsat¹⁰ presented the pathologic and clinical features of 3 cases of extra-medullary plasmacytoma. The first of these occurred in the oral cavity, the second in a lymph node and the third showed involvement of the bones by the tumour.

Bhende¹¹ recorded a case of a malignant amelanotic melanoma of the skin in an Indian albino aged 27 years. It probably originated in a pre-existent nevus and the production of satellite tumours and metastasis in lymph nodes indicated the spread *via* lymphatics. The histological features were characteristic of a malignant melanoma.

Sirsat¹² reported a rare case for the first time in an Indian, of malignant melanoma of the nasal mucosa. The lesion consisted of spindle-shaped cells with large and hyperchromatic nuclei. The cytoplasm was basophilic and many cells contained small granules of melanin. The urine of the patient however did not show presence of melanin. The author¹³ analysed 16 cases of malignant melanoma of the skin and found the incidence on the lower extremities as high as 75%. The same author¹⁴ reported a case of malignant melanoma originating in the vagina of a woman aged 50. The patient also had adeno carcinoma arising from the sigmoid colon with metastasis in the cervical lymph nodes.

Ranadive¹⁵ presented observations on the role of gonadal hormones in inducing carcinoma of the breast. Two strains of mice gonadectomised within 36 hours of birth were treated with identical dose of hormones at maturity. The first group received estradiol coupled with testosterone. The morphology of mammary

9. Bhende, Y. M. (1952), Indian Med. Gaz., **87**, 158.
10. Sirsat, M. V. (1952), *Ibid.*, **87**, 139.
11. Bhende, Y. M. (1952), Indian J. Med. Sci., **6**, 755.
12. Sirsat, M. V. (1952), Indian Med. Gaz., **87**, 357.
13. *Idem*, (1952), Indian J. Med. Sci., **6**, 806.
14. *Idem*, (1952), *Ibid.*, **6**, 882.
15. Ranadive, K. J. (1952), Indian J. Med. Sci., **6**, 792.

glands and response of urogenital organs in the two strains were compared at the age of 5-7 months. Striking difference was noticed in the mammary architecture.

II. DISEASES DUE TO BACTERIA

Cholera :

Saha and Das¹⁶ investigated the physical and chemical characters of specimens of stools from cholera cases with a view to plan a rational treatment aimed at replacing the fluid lost from the body. They observed that apart from the sediment present in the stools which varied from 1-12%, the fluid ejected had physical and chemical properties resembling that of plasma less its proteins. The hydrogen ion concentration of the stool was less than that of the blood, obviously due to the fact that the stools contained slightly higher concentration of bicarbonates. The reduced concentration of proteins was obviously due to the faecal fluid being of the nature of a transudate from the plasma. The relative concentration of the electrolytes in the stool and plasma were similar to those between the plasma and the tissue fluid. The authors had injected 500 mg. of sodium thiocyanate and 5 ml. of 0.7% Evan's Blue in a few patients and found that while the thiocyanate appeared in the stool in reasonable concentrations within an hour of intravenous injection, Evan's Blue was conspicuous by its absence.

The average protein content of the filtered stool in cholera was found to be only 0.26 g. per 100 ml., which is similar to the protein content of the interstitial fluid. Few samples of stool were also estimated for their enzyme content and the authors observed marked activity of amylase, invertase, maltase, and alkaline phosphatase and slight or no activity of trypsin, peptidase and lactase. From the observations, the authors have concluded that the cholera stool is of the nature of a transudate from the plasma, the intestinal mucous membrane serving as a semi-permeable membrane.

Tuberculosis :

Mathur and Wahi¹⁷ studied the clinical and pathological manifestations of acute generalised miliary tuberculosis in Indians, from a review of clinical and autopsy material of 10 years at the Sarojini Naidu Hospital, Agra.

Leprosy :

Furniss¹⁸ reported a case of leproma in the female breast which simulated carcinoma. In the particular case, a lepromatous woman of 50 complained of an ulcer on the right breast, which was found to overlie a small firm mass in the breast. Other similar lumps were found in the same breast and a few in the other. Axillary lymph glands were also enlarged. Microscopic examination of the biopsy tissue showed that the mass consisted of a granuloma made up of closely packed histiocytes with some plasma cells and small round cells. Moderate numbers of acid fast bacilli were seen in the dermis and within the granulomatous mass, some of which were intracellular.

Gollerkeri, Gokhale and Ranade¹⁹ investigated 285 cases of leprosy for their serum reactions for Wasserman and/or Kahn tests. Seventy-one of these (about 25%) gave positive reactions in either/both tests. Many of the positive cases did not respond clinically to antisyphilitic treatment, but responded well to anti-leprosy treatment with the sulphones. About 50% of a small number of active pulmonary tuberculosis also gave positive serological reactions. Out of 24 samples of spinal fluid of leprosy patients, 6 gave positive reactions. None of the 9 samples of fluids from cases of tuberculous meningitis was positive. They suggested that in addition to the globulin factor, the lipoids might also be important in the causation of the positive reactions.

Figueroedo and Desai²⁰ suggested a new method for detection of leprosy bacilli in neural cases and contacts. The method consisted of chloroform and ether extraction of the suspected tissue and

17. Mathur, K. S. and Wahi, P. N. (1952), Indian J. Med. Sci., **6**, 335.

18. Furniss, A. L. (1952), Indian Med. Gaz., **87**, 304.

19. Gollerkeri, P. G., Gokhale, B. B. and Ranade, S. N. (1952), Indian J. Med. Sci., **6**, 357.

20. Figueroedo, N. and Desai, S. D. (1952), Indian J. Med. Sci., **6**, 296.

examination of Ziehl-Neelsen staining of the extracted material. The authors claim that their method is better and more sensitive than the other methods commonly employed.

Syphilis.

Rajam and Rangiah²¹ reported for the first time in India a case of prenatal syphilis in one of fraternal twins.

Fungi:

Jayaram and others²² reported a fatal case of suspected Blastomycosis of lungs in a man of 60. The sputum of the patient was found to contain a few large spherical and slightly ovoid cells with a thick refractile wall which were single and budding, about $10\text{-}15\mu$ in diameter and dispensed singly or in a few clumps. No mycelia were seen. On culture on blood agar and Sabouraud's glucose agar media, a few wrinkled waxy colonies, composed of budding yeast like cells, similar to the ones seen directly in the sputum, were obtained.

Andleigh²³ reported 3 cases of Rhinosporidiosis from Rajasthan, from where, he claims, no similar case has been reported before. All the cases were males between the ages of 14—45 years, and the left nostril was mostly affected. Except nose, no other part of the body was involved. In all cases, a history of swimming, associated with the onset of disease, was elicited.

Basu²⁴ made a brief study of certain species of *actinomycetes* from human sources. He described the cultural and morphological characteristics of the organisms isolated from 10 different sources of material. Konar and others²⁵ described a case of isolated renal actinomycosis. The urine of the patient contained a few greyish granules floating on it, which on examination, exhibited a central mass of entangled threads with radially

21. Rajam, R. V. and Rangiah, P. N. (1952), Indian J. Med. Assoc., **21**, 186.
 22. Jayaram, S. S., Sirsi, M., Ahmed, V. N. and Dayalu, T. K. (1952), *Ibid.*, **21**, 365.

23. Andleigh, H. S. (1952), Indian J. Med. Sci., **6**, 16.

24. Basu, C. C. (1952), Indian Med. Gaz., **87**, 237.

25. Konar, N. R., Sen Gupta, A. N. and De, S. N. (1952), *Ibid.*,

branching filaments at the periphery, which were surrounded by a variable number of pus cells, red cells and a few mononuclear cells. A pure culture of ray fungus was obtained on ordinary media in 24 hours at 37°C. The organism was gram-positive, non-acid fast and obligatory aerobic. The case did not respond to penicillin but responded well to Streptomycin and terramycin. Benerjee²⁶ reported a case of primary actinomycosis of the skin. The case, a woman of 60 years had a number of nodular swellings of different sizes. There were also some healed or active small sinuses at the back of the thorax. The pus from the sinuses did not reveal any fungus or mycelium on microscopic examination, but a growth of actinomycosis was cultivated after difficulty. The histological examination of nodule showed a granuloma composed of masses of round cells, a few giant cells and fibrous tissue.

Tribedi and Sarkar²⁷ reported a case of pulmonary actinomycosis. The lesion started in the lungs, markedly on the right, involved the pleura on the right side and coursed its way behind the diaphragm in between the psoas and quadratus lumborum on the right side as far down as the right iliac home. The contagious surfaces of the bodies of some of the vertebrae were also eroded by the process.

Others:

Gantayat and Suryaprasadarao²⁸ reported a case of Laurence-Moon-Biedl Syndrome in a boy of 12 years. The case was a complete picture of the syndrome with retinitis, polydactylism, obesity, genital dystrophy, mental deficiency and a highly suggestive familial occurrence. There was also involvement of the 8th cranial nerve and deformity of talipes equinovorus.

Mukherji²⁹ recorded a case of empyema in a female child of 5 years, where, the causative organism isolated was Friedlander's pneumobacillus. He stressed the importance of early diagnosis of such cases for efficient treatment with antibiotics.

26. Banerjee, B. N. (1952), Indian Med. Gaz., 87, 253.
27. Tribedi, B. P. and Sarkar, S. K. (1952), Indian J. Med. Sci., 6, 591.
28. Gantayat, S. N. and Suryaprasadarao, R. (1952), J. Indian Med. Assoc., 21, 367.
29. Mukherji, A. B. (1952), Indian Med. Forum, 3, 145.

Tribedi *et al*³⁰ recorded a case of meningitis due to *Salmonella paratyphi C* infection. In this case, *Salmonella para C* was isolated from the pus found over the meninges at an autopsy. The heart-blood was found to be sterile on culture.

Lal and Aggarwal³¹ presented blood and bone marrow pictures of 2 cases of *Brucellosis*, one of typhoid and one of typhus, before, during and after the administration of chloromycetin. They observed a transitory maturation arrest of the neutrophil series of cells in the bone marrow simultaneous and proportionate with the administration of the drug which however did not cause any permanent damage.

Gupta³² studied the anti-bacterial properties of garlic and observed that garlic juice exerts a bacteriostatic action on most of the common bacteria. His experiments suggested that there were at least two anti-bacterial substances in garlic juice, one of which was volatile and the other soluble in water and oil. It was also observed that the anti-bacterial properties of garlic deteriorated on keeping, by heating and in the presence of alkalies, but not by acids or organic matters. The deterioration was much lower when stored at 10°C.

III. DISEASES DUE TO VIRUS

Rabies :

Thomas³³ attempted to identify and eliminate the factor responsible for paralytic accidents in the prophylactic or therapeutic treatments with anti-rabic vaccines. All attempts to remove the paralytogenic factor from the brain tissue, however, failed.

D'Silva³⁴ continued his studies on rabies. He recorded instances of 'fatal neuro-sterilization' and of 'recovery' from rabies. He described three cases of experimentally induced

30. Tribedi, B. P., Banerjee, C. R. and Sen, S. K. (1952), Indian J. Med. Sci., **6**, 591.

31. Lal, H. B. and Aggarwal, L. C. (1952), A. M. C. Journal, **7**, 11.

32. Gupta, S. P. (1952), J. Indian Med. Assoc., **21**, 430.

33. Thomas, A. K. (1952), Indian J. Med. Res., **40**, 121.

34. D'Silva, C. B. (1952), *Ibid.*, **40**, 317.

rabies of prolonged duration and in one instance virus was recovered from a guinea pig after 38 days of illness.

Poliomyelitis:

Gharpure and Swaminathan³⁵ presented the cerebro-spinal fluid findings in monkeys experimentally infected with known 'polio' material. The cerebro spinal fluids were examined for cells and proteins soon after withdrawal. In the series of animals inoculated intranasally, and which were subsequently proved to be positive, increase of cells and proteins in the C. S. F. was consistently observed at a stage when there was often no clinical evidence of the disease. In the animals inoculated successfully by the thalamic route, a similar increase of cells and proteins in the C. S. F. were noted at about the 5th and 7th day following the inoculation. They found the average incubation period for this route of inoculation to be 6-7 days, by which time the animal manifested at least the minimal detectable clinical evidence of the disease, *viz.*, weakness and paralysis of the muscles. The same authors³⁶ while studying the duration of infectivity of material containing virus of poliomyelitis found that the virus strain could survive for about 10 months when preserved in 50% neutral glycerine and stored in clean glass vials at temperatures ranging from 4°C to 5°C.

Iyer and Swaminathan³⁷ recorded the isolation and maintenance of the strains of virus of poliomyelitis from clinical cases of the disease. The strains were maintained by passage in monkeys.

Gharpure and Bhatt³⁸ reported two unusual manifestations in human poliomyelitis. In one, there developed paralysis of a limb in a case of poliomyelitis in which an injection of quinine hydrochloride was given. In the other case there was a second attack of poliomyelitis in the same child after about 2 months.

35. Gharpure, P. V. and Swaminathan, C. S. (1952), Indian J. Med. Sci., **6**, 579.

36. *Idem*, (1952), *Ibid.*, **6**, 584.

37. Iyer, C. G. S. and Swaminathan, C. S. (1952), *Ibid.*, **6**, 764.

38. Gharpure, P. V. and Bhatt, P. R. (1952), *Ibid.*, **6**, 576.

Others :

Banker³⁹ presented his preliminary observations on antibody pattern against certain viruses among inhabitants of Bombay City. About 90% of the sera examined showed presence of neutralizing antibodies to the Lansing strain of poliomyelitis virus. Of the sera tested for neutralizing antibodies to the High Point strain of Coxsackie virus, all from persons of 4 years and above were positive. For the other 3 types of Coxsackie viruses, the frequency of positive results was not so high. Presence of neutralizing antibodies to the Herps simplex virus and the Yale strain of B-like virus showed a rising incidence through childhood to young adulthood and a decline after the age of 40 years. Of the 40 sera tested for presence of neutralizing antibodies to the Egyptian strain of West Nile virus, 4 were found to be positive.

Banerjee⁴⁰ studied 21 cases of post-variolar pyogenic arthritis and osteomyelitis, and recorded with details the variations in the mode of onset of bone and joint infections.

IV. DISEASES DUE TO HAEMOPARASITES

Malaria :

Wahi and Arora⁴¹ made a critical study to determine the degree of liver involvement in acute and chronic malaria. By analysis of results of different liver function tests in 50 cases of acute malaria, they found that flocculation and bromsulphathalein retention tests were the ones which gave abnormal readings in the majority of the cases. In 10% of cases there was no test positive, indicating that liver damage was absent or so mild as not to produce any functional change. Ninety % of the cases had one or more tests positive of which 36% had only one test positive. The authors concluded that none of the liver function tests used was accurate, when used alone, as an index of hepatic dysfunction. The same authors⁴² also found that 98.4% of cases of chronic malaria had one or more tests positive, the majority having 5 or 6

39. Banker, D. D. (1952), Indian J. Med. Sci., **6**, 733.

40. Banerjee, N. M. (1952), Indian Med. Gaz., **87**, 244.

41. Wahi, P. N. and Arora, M. M. (1952), Indian J. Med. Sci., **6**, 165.

42. *Idem*, (1952), *Ibid.*, **6**, 235.

tests positive. The damage was more or less of a permanent nature. They also found that the type of malarial infection and the nature and number of tests showing positive results had no relationship and that the number of relapses and the duration of the attacks had no influence on the extent of liver derangement.

Leishmaniasis :

Sen Gupta and Adhikari⁴³ presented results of Complement-
Fixation test for Kala-azar using an antigen prepared from Kedrowsky's acid fast bacillus. Out of 2,046 sera tested, 1917, i.e., 94.6% gave positive reaction. Positive reactions were obtained in early, moderately advanced and chronic cases of Kala-azar and from 3rd week and onwards of the acute onset of the disease. The authors are of opinion that the test is of great value in the serum diagnosis of Kala-azar and is the test of choice for the early stages of the disease when all other serum tests are negative.

V. DISEASES DUE TO INTESTINAL PARASITES

Amoebiasis :

De and Sen Gupta⁴⁴ reported a fatal case of perforation of an amoebic ulcer of the appendix in a girl of 8 years. On histological examination of the appendix, at autopsy, vegetative forms of *Entamoeba histolytica* were seen in groups and singly within small rarefied foci among the muscle fibres deep to the necrotic edge of the perforation.

Chakravarti⁴⁵ reported 12 cases of pulmonary amoebiasis, two of which were of primary variety and the others belonging to the secondary variety. In 7 cases diagnosis was confirmed by presence of entamoeba in the sputum.

Ankylostomiasis :

Chand⁴⁶ described 100 cases of ankylostomiasis from amongst the rural population of Sirmur district in Himachal Pradesh, where

43. Sen Gupta, P. C. and Adhikari, S. L. (1952), J. Indian Med. Assoc., 22, 89.

44. De, S. N. and Sen Gupta, K. A. (1952), J. Indian Med. Assoc., 21, 243.

45. Chakravarti, A. (1952), *Ibid.*, 21, 387.

46. Chand, D. (1952), Indian Med. Gaz., 87, 142.

the disease had not existed so far. He worked out the incidence amongst hospital admissions and analysed the clinical and haematological aspects. He observed a high incidence of infection and consequent anaemia in the women folk of the hills and suggested a possible relationship of the infection with repeated abortions in them. He also observed a close simulation of the clinical pictures to peptic ulcer.

Chaudhuri,⁴⁷ while studying hookworm infected cases found that 56.2% of the patients had occult blood in their stool. The effect of deworming on the presence of occult blood in the stool was also noted in 27 patients and it was found that in 74.1% cases occult blood disappeared after deworming. The same author⁴⁸ studied 153 hookworm cases from the point of view of determining the eosinophil percentage, leucocyte count and relationship between haemoglobin percentage and eosinophil percentage. He found that in majority of the cases total leucocyte count was between 4,000 to 8,000 with eosinophil percentage between 5 and 15. It was also seen that as haemoglobin percentage went down the eosinophil count also went down.

Others :

Bhattacharya⁴⁹ reported a case of duodenal ulcer associated with infection with a large number of intestinal parasites, viz., *Giardia intestinalis*, *Ascaris*, *Ankylostoma*, *Tricuris trichuria* and *Ent. histolytica*. The author suggested the possibility of duodenal ulcer being caused by irritation to the duodenum by the parasites.

Samuel Raj⁵⁰ reported a case of myasis of the urinary passage in a youngman. The patient, during each micturition, used to pass about a dozen maggots, which continued for a period of about 2 months. The maggots measured from 4 mm. to 7 mm. in length and the body was 12 segmented. The structure showed that they were different from all myasis-producing larvae recorded so far.

47. Chaudhuri, K. D. (1952), Patna J. Med., **26**, 5.

48. *Idem*, (1952), *Ibid.*, **26**, 125.

49. Bhattacharya, I. B. (1952), J. Indian Med. Assoc., **21**, 481.

50. Samuel Raj, J. (1952), Curr. Sci., **21**, 222.

Tribedi and others⁵¹ recorded only one case of hydatid disease out of 2,989 autopsies performed during last 31 years. The cyst was found in the upper lobe of the left lung in the subapical zone and was about 2" x 1½" in size. The liver was not involved showing that the embryo reached the lung through the pulmonary artery gaining access to the general blood stream, probably bypassing the liver or through the liver.

Gharpure⁵² recorded further observations on his study on helminthic antigens. He looked for antigenic substances in the fluid in which ascaris were living in the laboratory, by injecting the fluid into the rabbits. The sera collected from the rabbits were examined and found not to possess any antibody. He concluded that the substance elaborated by ascaris *in vitro*, served as a partial antigen.

VI. DEFICIENCY DISORDERS

Banerjee⁵³ reported an unusual case of *pellagra* in a woman of 40 years. The dermatitis was unusually extensive and was present not only over the exposed parts, *viz.*, hands, legs and forehead as was commonly met with, but it was also in the covered areas, such as on the front and back of the thighs, knees, sacral area, loin and anterior abdominal wall. Diarrhoea, a common feature of *pellagra*, was absent in this case. There was a dramatic response to nicotinic acid.

Modi⁵⁴ presented clinical data of 37 patients with cirrhosis of the liver with ascites treated with a highly nutritious diet. A certain amount of correlation between laboratory investigation and the clinical course of the cases was observed. After treatment, 15 were clinically cured, 10 showed fair amount of improvement, 3 showed no improvement and 7 died. Progressive increase in the serum albumin values was a good measure of the patient's clinical improvement.

51. Tribedi, B. P., Chowdhury, B. and Barua, D. (1952), Indian J. Med. Sci., **6**, 591.
 52. Gharpure, P. V. (1952), *Ibid.*, **6**, 601.
 53. Banerjee, D. (1952), Indian Med. Gaz., **87**, 161.
 54. Modi, N. J. (1952), J. Indian Med. Assoc., **21**, 379.

VII. MISCELLANEOUS DISORDERS

Toxaemias of Pregnancy :

Mukherjee⁵⁵ described the results of a series of experiments designed to study the rate of sugar utilization in toxæmias of pregnancy. He observed that the rate of utilization of sugar in normal pregnancy was slightly less than that in non-pregnant subjects. In toxæmias of pregnancy this was even less. It was found that pre-eclampsia affects sugar utilization in the body more adversely than essential hypertension complicating pregnancy. Simultaneous study of the sugar utilisation and gonadotrophin concentration showed that the two were inversely related to each other. Available evidences suggested that the decreased sugar utilisation in toxæmias of pregnancy was due to a disturbance of the endocrine equilibrium, in which hyperfunction of the pituitary was an important feature. The author⁵⁶ estimated blood sugar in a series of 78 cases of normal pregnancy and 100 cases of pre-eclampsia. No significant change in the concentration of blood sugar was observed in the latter condition. The eclamptic convulsions were also not found to be in any way related to fluctuations in the blood sugar level. The author⁵⁷ thought that the diminished sugar mobilisation in preclampsia and in eclampsia was not due to a deficient consumption of carbohydrates. It might probably be related to the state of vascular spasm and the functional status of the pituitary body.

Mukherji⁵⁸ also presented the results of a study of the acid-base balance of the body in 14 cases of normal pregnancy, 30 cases of pre-eclampsia and 14 cases of eclampsia. The findings indicated that although there was a decrease in the alkali reserve of the blood in pregnancy and a greater decrease in toxæmias, in both normal pregnancy and pre-eclampsia the condition was one of compensated alkali deficit. The functional integrity of the carbonic buffer was not upset and the pH of the blood did not deviate from the normal. In eclampsia, however, especially in

55. Mukherjee, C. (1952), *J. Indian Med. Assoc.*, **21**, 135.

56. *Idem*, (1952), *Ibid.*, **21**, 183.

57. *Idem*, (1952), *Ibid.*, **21**, 279.

58. *Idem*, (1952), *Ibid.*, **21**, 411.

presence of coma and frequent convulsions, the acid-base balance was grossly disturbed and the condition which developed was one of uncompensated alkali deficit acidæmia. The carbonic buffer system was disturbed and the pH had a slight tendency to fall. The author also made a study on ketosis in normal and toxæmic pregnancy. He found that in toxæmia the tendency to ketosis was increased. In pre-eclampsia, this was not attended with a gross disturbance of the buffer mechanism of the blood.

Mukherjee⁵⁹ also presented the results of bilirubin excretion test on 138 cases of toxæmia of pregnancy. Pre-eclampsia, and accidental haemorrhage eclampsia caused an increased retention of bilirubin, and the improvement or deterioration of the toxæmia were associated with a corresponding decrease or increase in bilirubin retention. He found that eclamptic state and shock had a deleterious effect on bilirubin excretory capacity of the liver. According to Mukerjee, persistence of abnormal values in the late second week of puerperium would indicate some organic disorder of the liver.

Blood disorders :

Dunlop and Mozumder⁶⁰ studied three cases of Sickle-cell anaemia occurring in children of labourers of tea gardens of Assam, along with 8 more latent cases with similar traits among members of their families. All the cases confirmed to text-book picture.

Buch⁶¹ presented 8 cases of *Erythroblastosis foetalis* and has analysed 14 cases from the view points of community represented and treatment carried out. Of the cases presented, in four, there has been Rh saline or blocking antibody in the maternal serum. In other four cases the Rh factor heterospecificity between mother and infant was very suggestive of the presence of iso-immunisation by the Rh factor, but maternal sera did not contain immune Rh saline or blocking antibody.

59. Mukherjee, C. (1952), Indian J. Med. Sci., **6**, 869.

60. Dunlop, K. J. and Mozumder, U. K. (1952), Indian Med. Gaz., **87**, 387.

61. Buch, S. C. (1952), Indian J. Med. Sci., **6**, 1.

Gour and Seth⁶² while studying 960 patients suffering from anaemia observed that 400 cases were associated with gastrointestinal tract disorders. They tabulated the different causes of anaemia from which it could be seen that ankylostomiasis was responsible for anaemia in 26% of the cases. The next important cause was found to be chronic diarrhoea including chronic dysentery and colitis. This group comprised of 100 cases consisting of 68 (17%) cases where anaemia was due to chronic diarrhoea, 27 (6.75%) cases due to dysentery and 5 (1.25%) cases due to colitis. Of other causes, 53 (13.25%) cases were due to abdominal tuberculosis, 16 (4.0%) cases were due to sprue. In 4 cases gastric carcinoma was detected and in 29 cases there was diarrhoea associated with giardiasis.

Kothari and Bhende⁶³ made an extensive study of 100 cases of nutritional megaloblastic anaemia of pregnancy and recorded their detailed haematological and biochemical findings.

Reddy⁶⁴ recorded his observations on the study of bone marrow in normal health and in a few select pathological conditions. He referred to a special type of sternal puncture needle devised by himself by which he claims that bone marrow undiluted with peripheral blood can be obtained.

Others :

Aikat and Sharma⁶⁵ presented the clinical summary and the detailed autopsy findings of a case of gross hepatosplenomegally in a boy aged 15 years. They found cavernomatous malformations of the intra-hepatic branches of the portal vein as a cause of fibrocongestive splenomegaly.

Reddy and Anguli⁶⁶ reported a case of Gaucher's disease diagnosed by spleen puncture and histological examination. The splenic puncture showed a number of irregularly shaped alveolar spaces either lined or filled with Gaucher's cells. The lipoid of the

62. Gour, K. N and Seth, A. K. (1952), Indian J. Med. Sci., **6**, 189.

63. Kothari, B. V. and Bhende, Y. M. (1952), Indian J. Med. Res., **40**, 387.

64. Reddy, D. G. (1952), Indian J. Med. Sci., **6**, 424.

65. Aikat, B. K. and Sharma, K. D. (1952), *Ibid.*, 603.

66. Reddy, D. G. and Anguli, V. C. (1952), Indian Med. Gaz. **87**, 358.

Gaucher's cells which is kerasin was demonstrated by staining the paraffin sections with periodic acid and leuco-fuchsin, which gave the Gaucher's cells the characteristic brilliant rose purple tint. The sternal puncture smears did not show any Gaucher's cell.

Vakil and Golwalla⁶⁷ reported a case of multiple arteriosclerotic aneurysms in a man of 65. There were two aneurysms of the aorta, one on the arch, and the other, bigger one, was on the descending aorta. There was a separate small aneurysm arising from the left pulmonary artery and another in connection with the splenic artery. Wassermann and Khan tests were negative.

Tribedi and Chanda⁶⁸ reported a case of Polyarteritis nodosa in a man of 20, which was diagnosed at autopsy. The patient had only 4% eosinophils in the blood. The vessels of heart, kidney, spleen, lungs, liver, and testis all showed fibrinoid degeneration of the wall and perivascular cellular infiltration. Femoral, brachial and basilar arteries were normal in appearance.

Gupta and others⁶⁹ found an increase of eosinophils from 2 to 16% in a group of 40 mice inoculated intraperitoneally and intravenously with Seitz filtered blood and sera of patients suffering from tropical eosinophilia. Progressive increase in eosinophils was also recorded in 5 monkeys similarly inoculated. There was a corresponding increase in total leucocyte count from 6,000 to 13,000 per c.mm. of blood. The authors also observed agglutination of chicken red cells with patient's sera. The haemagglutination titre did not reach more than 1:32.

Gault and others⁷⁰ reviewed a series of 50 cases of cystic disease of the lungs treated by lobectomy. They found the age incidence varying from 2½ to 69 years with more than half the cases between 21 and 40 years of age, and a much higher incidence among men. The authors recorded the lobar distribution of the lesion. They found the histological picture in bronchiectasis to present a fairly constant pattern.

67. Vakil, R. J. and Golwalla, A. F. (1952), Indian Med. Gaz., **87**, 255.

68. Tribedi, B. P. and Chanda, N. K. (1952), *Ibid.*, **87**, 450.

69. Gupta, B. M., Misra, S. S. and Hameed, S. (1952), Curr. Sci., **21**, 78.

70. Gault, E. W., Asirvadham, M., D' Sena, G. W. L., Thomas, E. and Varunny, E. (1952), Indian J. Med. Sci., **6**, 673.

Rananavare⁷¹ reported a case of Waterhouse-Friderichsen Syndrome in a 24-year old American lady, in which the clinical history and the *post mortem* findings showed the death to be due to sudden circulatory failure as a result of severe bleeding around the adrenals on both sides. The case differed from the classical syndrome in its etiology, in that the case was one of blood dyscrasia aggravated by the administration of an anticoagulant. There was no meningococcal septicaemia.

Chhuttani⁷² described 35 cases of Koilonychia and 13 cases of platyonychia. He found that hook worm infestation, syphilis, chronic malaria with splenomegaly, thyrotoxicosis and Addison's disease were some of the associated factors of koilonychia. He concluded that as a broad rule iron deficiency was probably the underlying cause.

VIII. CLINICAL PATHOLOGY

Haematology :

Ghosh and Das Gupta⁷³ worked out a method for preparation of Leishman stain with ethyl alcohol for the purpose of staining blood cells and parasites. In this method, 0.15 g. of Leishman stain is dissolved in a solvent consisting of 10 ml. of neutral and anhydrous glycerol, 10 ml. of water, and made up to 100 ml. with absolute ethyl alcohol. Chakravarthy⁷⁴ suggested another modification of Leishman stain, prepared by dissolving 200 mg. of the powdered stain in 100 ml. of aldehyde free absolute ethyl alcohol, and incubating at 37°C for 24—48 hours. He found this stain as satisfactory as the one prepared with methyl alcohol.

Swamy and Dutta⁷⁵ devised a line chart to determine the absolute corpuscular values, *viz.*, M. C. V., M. C. H. and M. C. H. C., from the experimental findings of erythrocyte count, haemoglobin estimation and packed cell volume. The use of the nomogram should be very useful on account of the fact that evalua-

71. Rananavare, M. M. (1952), Indian J. Med. Sci., **6**, 204.

72. Chhuttani, P. N. (1952), *Ibid.*, **6**, 177.

73. Ghosh, S. K. and Das Gupta, C. R. (1952), Indian Med. Gaz., **87**, 302.

74. Chakravarthy, R. K. (1952), *Ibid.*, **87**, 404.

75. Swamy, T. V. and Dutta, B. B. (1952), *Ibid.*, **87**, 300.

tion of these values by mathematical calculation would be time consuming.

Deshmukh and Kundalkar⁷⁶ made haematological studies in 100 cases of children apparently healthy. The mean value of haemoglobin content was found to be 12.9 g. per 100 ml. The total red and white cell counts were 4.99 million and 8,180 per c.mm. respectively, and the average differential counts for the leucocytes was 45.83, 43.10, 6.82 and 4.02 per cent, respectively, for neutrophils, lymphocytes, eosinophils and monocytes.

Mookerjee and Ghose⁷⁷ studied the haematological response of a group of Indian troops at moderately high altitude, in extreme cold environment. Observations on local acclimatized civilians were compared with those of the army group. They observed the increase in the number of the red blood cells on the 10th day of acclimatization, but the response was not well marked. P. C. V. and M. C. V. showed higher values than found in the plains. It was noted that the rise of haemoglobin level was not significant till the 50th day of acclimatization period. The authors stressed the influence of the animal-protein fraction of the diet on the overall haematological picture during response to anoxia.

Bird⁷⁸ studied the haemagglutinins present in the seeds of *Dolichos biflorus*. He found that extract of one of the strains of the plant, *Belgaum 1-1-8*, agglutinated A₁ and A₂ cells in titres of 32, 768 and 16 respectively. He suggested that the latter extract could be used as a substitute for human anti-A sera. With this view, he⁷⁹ made comparison of the activity of a saline extract of *Dolichos biflorus-Belgaum 1-1-8* with human anti-A blood grouping sera of standard titre and avidity, and found that the titre of the plasma extract was much higher than that of the standard anti-A sera against A₁ and A₁B cells, but was lower against A₂ and A₂B cells. Bird also found that the extract was superior to human sera in some respects but inferior in others.

76. Deshmukh, H. K. and Kundalkar, O. G. (1952), Indian Med. Gaz., **87**, 455.

77. Mookerjee, G. C. and Ghose, B. K. (1951), Indian J. Med. Res., **39**, 543.

78. Bird, G. W. G. (1951), Curr., Sci., **20**, 298.

79. *Idem.* (1952), Indian Med. Res., **40**, 289.

The same author⁸⁰ also found that extracts of the common potato, *Solanum tuberosum*, contained haemagglutinins of a non-specific nature. The titre was only 128 against O, A, and B cells, but the agglutinates produced were very large.

Rao⁸¹ studied blood group characteristics in South Indians, and has given the distribution of A_1A_2BO groups and M-N types by examining 394 and 60 people respectively. Random individuals (132) were tested for Rh factor of which 96.2% were found Rh positive and 3.8% Rh negative. Saliva samples of 200 individuals belonging to groups A, B, and AB were tested for the secretion of the group-specific substances; 70.5% were found to be secretors and 29.5% were non-secretors. Iso-haemagglutinin titre of 100 individuals each of group A, B and O were determined, and 14%, 29% and 16% of respective groups were found to have a titre above 320. Nine% of group O individuals had a titre of 640 or above.

Chatterjee⁸² estimated blood volumes by the Evan's Blue method in 115 male and 39 female subjects. The average plasma and blood volumes observed were 48.61 and 84.58 ml./kg. respectively for males, and 51.48 and 83.26 ml./kg. respectively for females. She⁸³ also made repeated plasma volume determinations at intervals of 1 to 35 days on 6 individuals. The statistical analysis of the values showed no significant difference between the two determinations either in the plasma volume or total cell mass in any one of the groups. There was no evidence of erroneously high value in the first determination as a result of immediate absorption of the dye by the reticuloendothelial system, *viz.*, the so-called "cat effect." There was also no significant difference of the values of plasma volume estimated from the different veins of upper and lower extremities. The author⁸⁴ further determined blood volume in 21 cases operated upon under spinal anaesthesia. The determinations were made before the anaesthesia and at intervals varying from 17 to 130 minutes.

80. Bird, G. W. G. (1952), *Curr. Sci.*, **21**, 195

81. Rao, A. K. (1952), *Ibid.*, **21**, 188.

82. Chatterjee, P. (1952), *J. Indian Med. Assoc.*, **21**, 231.

83. *Idem*, (1952), *Ibid.*, **21**, 284.

84. Sircar (see Chatterjee) (1952), *Ibid.*, **21**, 340.

The total cell mass did not significantly alter with the time of anaesthesia but the plasma volume presented a regular log. parabolic curve with an initial depression, middle elevation upto the resting level and last a final phase of decompensation at 45, 95 and beyond 95 minutes of anaesthesia. The mean values showed significant difference between groups. The systolic blood pressure was found to be directly related to the change of plasma volume. The same author made a co-ordinated study of the plasma volume, total cell mass, haemoglobin and blood pressure on patients anaesthetized with nitrous oxide, oxygen and ether mixture. She observed a significant drop of plasma volume under anaesthesia.

Cyto-diagnosis:

Wahi and Mehta⁸⁵ presented the results of the study of serial vaginal smears and endometrial biopsies from 30 sterile women, and discussed the applicability of the smear method to the diagnosis of ovulation. They noted that the ovulatory menstrual cycle could be characterised by a definite composite smear pattern built up by the successive phases—menstrual, pre-menstrual, pre-ovulatory, ovulatory, post-ovulatory and pre-menstrual phases. They found that the picture of desquamation or curling of cells and their groupings, accompanied by a decline in the numbers of cornified cells may be regarded as diagnostic of ovulation. Smears varying widely from this pattern are suggestive of ovulatory failure.

Shah⁸⁶ recorded his observations made during the study of vaginal cytology of 69 women suffering from sterility, amenorrhoea or uterine bleeding. He found definite evidence of the occurrence of ovulation and progesterone activity in 17 out of 19 regularly menstruating sterile women.

Wahi and Jain⁸⁷ made an intensive study of cytological diagnosis of cervical cancer. In a group of 300, they had 117 cases with positive cytology of which only 5 cases were not confirmed by histology. Of 183 cases of negative cytology, confirmation was not available in 6 cases.

85. Wahi, P. N. and Mehta, U. (1952), Indian J. Med. Sci., **6**, 477.

86. Shah, P. N. (1952), *Ibid.*, **6**, 683.

87. Wahi, P. N. and Jain, R. L. (1952), *Ibid.*, **6**, 343.

Wahi⁸⁸ examined 52 cases of pathological prostates by smear method, of which there were 15 patients with carcinoma of the prostate, in whom diagnosis was proved by paraffin section in 12 and clinically in 3. Cancer cells were found in 13 of the 15 cases. There were no false positives, but 2 cases with negative cytology were found to be malignant by biopsy method.

Bacteriology :

While studying sterility tests of chemical solutions meant for parenteral administration, Sen Gupta⁸⁹ observed that in cases where the preparations had bacteriostatic properties, unless sufficient quantities of media were employed, the tests would be of no significance. He worked out the maximum non-bacteriostatic concentrations of a number of common chemical injectable solutions against organisms.

Serology :

Subramanyan⁹⁰ presented his results of agglutination reaction against *Salm. typhosum*, studied in a series of 11 cases of typhoid fever diagnosed during the first week and treated with Chloromycetin. He found the level of agglutinin in the blood as nil or very low and concluded that Chloromycetin denatured the bacteria and prevented formation of specific agglutinins.

Mitra,⁹¹ while analysing results of W. R. and Kahn tests on sera, observed that 64.67% of the cases showed absolute agreement in the W. R. and Kahn results, and there was absolute disagreement in 7.10% cases. The author recommended that both the tests should be performed as a routine for serological diagnosis of syphilis as otherwise one might miss about 10% of the infected cases.

Waller and Sen⁹² studied Ford Robertson and Colquhoun's modification of Meinicke's clarification test. The test was found to be sensitive and more reliable than the W. R. and Kahn test in the sero-diagnosis of syphilis. In early syphilis, the F. R. C. test was positive long before the W. R. and Kahn, and in those under-

88. Wahi, P. N. (1952), Indian J. Med. Sci., **6**, 347.

89. Sen Gupta, P. N. (1952), Indian J. Med. Res., **40**, 115.

90. Subramanyan, P. (1952), J. Indian Med. Assoc., **22**, 99.

91. Mitra, S. (1952), Indian Med. Forum, **3**, 116.

92. Waller, S. O. and Sen, S. (1952), A. M. C. Journal, **8**, 1.

going treatment it remained positive after the W. R. and Kahn had become negative. The test was never positive in malaria and was positive in only 14% cases of leprosy. The authors are of opinion that as a single test, the F. R. C. test is best of all.

Lahiri and More⁹³ studied the naturally developed diphtheria antitoxin titre of a random Indian population numbering 294, men and women. They found that a large number, who had never been artificially immunised against diphtheria before, showed a diphtheria anti-toxic titre exceeding 0.05 international units. About 4% showed titre less than 0.01 I.U.

Biochemistry :

Chaudhuri and others⁹⁴ estimated the extracellular fluid by thiocyanate in 17 healthy Indians. They found the value for available thiocyanate space as 236.3, 30.8 ml. per Kg. and for interstitial fluid as 160.0 26.3 ml. per Kg. The same authors⁹⁵ also studied body fluid changes in 17 cases of cholera and found that plasma volume per kilogram was below the line of normal regression in all the cases. In fatal group there was a reduction of 32% of the mean normal value. In the survival group the reduction was 20%. Changes in the interstitial fluid in the survival group were however less marked but in the fatal group the mean value was 39% reduced. Percentage value of plasma chloride was within normal limit or slightly raised in all the cases. The total quantity of the circulating chloride, however, was markedly decreased in all the cases, especially so in the fatal group. In the follow up cases all the body fluid and the cellular changes were corrected with recovery. Body fluid changes in acute febrile conditions were investigated by the same authors⁹⁶ in 37 cases of enteric fever, 7 cases of pneumonia and 18 cases of malaria. In all the cases plasma volume was found to be increased so as to maintain a standard blood volume even in presence of toxic destruction of the erythrocytes. There was also increase in the

93. Lahiri, D. C. and More, V. Y. (1952). Indian Med. Gaz., **87**, 448.

94. Chaudhuri, R. N., Chakravarti, H. and Dutt, B. N. (1951), Indian J. Med. Res., **39**, 553.

95. *Idem*, (1951), *Ibid.*, **39**, 559.

96. *Idem*, (1951), *Ibid.*, **39**, 571.

thiocyanate space values, probably due to increased permeability of the cell membrane to thiocyanate radical due to the diseased conditions.

Saha and Sen Gupta⁹⁷ studied 30 cases of renal, hepatic and nutritional oedema. They observed that in renal oedema, the plasma volumes were unaltered while the thiocyanate space was remarkably expanded, so that the ratio, tissue fluid plasma volume, was considerably higher than the normal. This was associated with marked increase of anti-diuretic hormone secretion. In cases of oedema associated with cirrhosis of the liver, the plasma volume and thiocyanate spaces were both increased and so the ratio plasma volume tissue fluid was only slightly higher than normal, and the urinary antidiuretic hormone excretion was moderately increased in 3 out of 4 cases. In nutritional oedema, on the other hand, both the thiocyanate space and plasma volume were considerably increased but the ratio was not significantly changed. There was evidence of rather sub-normal amount of anti-diuretic hormone in urine. The author concluded that secretion of the hormone could be determined by the concentration of electrolytes in the tissue fluid which seemed to possess an apparent correlation with the tissue fluid and plasma volume ratio.

Neogy⁹⁸ presented the results of aldehyde test in 100 cases of pulmonary tuberculosis and observed that pulmonary tuberculosis alone did not give a positive reaction. The test was found negative in 91% cases, doubtful in 8% cases and positive only in 1% case, in which pulmonary tuberculosis was associated with Kala-azar.

Roy Chowdhury and Chadha⁹⁹ made observations on urobilinogen excretion in 92 healthy individuals and in 22 cases of diabetes mellitus. They found that in most of the cases urobilinogen could just be detected in the undiluted urine. In 4 normals it was positive in 1:10 dilution of the urine and in 2 cases, positive in 1:20. In the series of diabetes mellitus, all

97. Saha, H. and Sen Gupta, K. P. (1952), *J. Indian Med. Assoc.*, **22**, 1.

98. Neogy, B. V. (1952), *J. Indian Med. Assoc.*, **21**, 140.

99. Roy Chowdhury, A. K. and Chadha, V. N. (1952), *Indian Med. Forum*, **3**, 79.

cases with coma, showed a high urobilinogen output. The excretion of urobilinogen continued to be high even after improvement in general condition. These cases of diabetes without coma did not show increased output of urobilinogen. The authors think that the high output of urobilinogen in cases of diabetic coma is an indication of the liver damage.

Nandi¹⁰⁰ performed thymol-turbidity test in 55 cases of schizophrenia, 20 normal subjects and 50 confirmed cases of damaged liver. He noted evidences of damaged liver in a large number of schizophrenics, and found that the state of liver function is related to mental state. The same author¹⁰¹ also studied liver function by Quick's benzoic acid test and concluded that conjugation function of liver was definitely impaired in catatonic schizophrenia. The test also gave positive results in large number of paranoid-hebephrenic group of schizophrenics. It, therefore, appears that there is some derangement of protein metabolism in schizophrenia.

Joshi and Desai¹⁰² suggested a new method for determining the total tocopherols in plasma. In this method the proteins are precipitated with ethyl alcohol and the tocopherols are extracted by chloroform. The chloroform extract, after dilution with α - α -dipyridil is treated with ferric chloride, and the resultant pink colour is measured in a photoelectric colorimeter with 520 m μ filter. The workers have studied the influences of several factors on the colour formation and have suggested a procedure which can differentiate between physiological and non-physiological inhibitors of tocopherol utilization.

Mukherjee and Saha¹⁰³ presented the results of pregnancy diagnosis tests on *Rana tigrina* in a series of 268 cases. There was 100% agreement in 51 control cases. In 140 cases of pregnancy the incidence of accuracy was 98.57%.

100. Nandi, D. N. (1952), Indian J. Med. Res., **40**, 295.

101. *Idem*, (1952), *Ibid.*, **40**, 303.

102. Joshi, P. N. and Desai, R. G. (1952), Indian Med. Res., **40**, 277.

103. Mukherjee, C. and Saha, H. (1952), J. Indian Med. Assoc., **21**.

PHARMACOLOGY

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The year under review has shown a considerable increased activity in pharmacological investigations. Most of the studies have centred round indigenous drugs and Indian medicinal plants. The synthetic compounds as antimalarials and antitubercular agents have also been investigated; studies of antihistamines, spasmolytics and curariform substances have received some attention; the steriods of the gonads and adrenal cortex, and hormones in general, which are in the fore-front of the modern development in pharmacology, have been practically neglected.

Since the taxonomical characteristics of many of the plants investigated are uncertain and the chemical nature of the active fractions are unknown, investigations being mostly on crude or semi-purified extracts, though not the ideal, the therapeutic action is taken as the criterion in the following account.

Tuberculosis :

Tuberculosis, being still one of the unconquered diseases, has naturally attracted attention. The chemotherapeutic effectiveness of cepharanthine, an alkaloid from *Stephania cepharantha* was investigated by Sirsi and De.¹ It was found to be effectively tuberculostatic *in vitro* in a concentration of 2 μ g./ml., but ineffective in murine tuberculosis.

Atomized mica (*Shankerbharak*) on investigation by Bhatia² was found to have no inhibitory action on the growth of *Myco. tuberculosis*, *in vitro*, in a concentration of 1.5 mg./ml.; 0.2 ml. subcutaneously given thrice weekly had no effect on experimental tuberculosis in guinea pigs.

1. Sirsi, M. and De, N. N. (1952), Indian Med. Gaz., 87, 91.

2. Bhatia, A. L. (1952), Indian J. Med. Res., 40, 161.

A number of synthetic antitubercular compounds have also been tested. Suri³ determined *in vitro* activity of a few organic compounds related to para amino salicylic acid. The same worker⁴ assessed the therapeutic activity of TB 1/698 in experimentally induced tuberculosis in guinea pigs with graded doses of H₃₇ Rv strain, and reported that the antitubercular activity of TB 1/698 was inferior to that of dihydrostreptomycin sulphate and compared favourably with P. A. S. No significant beneficial effects were observed in clinical trials of acute exudative tuberculosis with TB 1/698.⁵

In presenting their observations on the antitubercular activity of *Isoniazid*, Suri and Bhatia⁶ observed that minimum inhibitory concentration of *Isoniazid* was much less than streptomycin, and no synergistic action of streptomycin and *Isoniazid* was seen *in vitro*.

Diabetes :

Rajaram and De⁷ isolated a glycoside from the leaves of *Rivea cuneata* N. O. Convolvulaceae. This had no immediate effect on blood sugar level, but brought down the blood and urine sugar to normal. Curative effect was lasting. Administration for 1 to 2 weeks restored diabetes to normal; relapse might occur after two years. The curative effect was claimed to be due to the production of hyperplasia of the islets of Langerhans.

Curariform substances :

Chemical examination of roots of *Cissampelos pereira* Linn. by Bhattacharjee, Sharma and Roy⁸ yielded the following constituents. i. Alkaloid hyatin (chief), ii. alkaloid hayatinin (subsidiary), iii. Quercitol, and iv. a sterol. Pradhan, Roy and Varadan⁹ tested

3. Suri, J. C. (1952), *Ibid.*, **40**, 1.

4. *Idem*, (1952), *Ibid.*, **40**, 131.

5. *Idem*, (1952), *Ibid.*, **40**, 151.

6. Suri, J. C. and Bhatia, A. L. (1952), *Ibid.*, **40**, 587.

7. Rajaram Rao, M. R. and De, N. N. (1952), *Current Sci.*, **21**, 69.

8. Bhattacharjee, S., Sharma, V. N. and Dhar, M. L. (1952), *J. Sci. and Ind. Res. India*, **11B**, 81.

9. Pradhan, S. N., Roy, C. S. and Varadan, K. S. (1952), *Current Sci.*, **21**, 172.

the toxicity and pharmacodynamic action of the alkaloid hayatin and some of its salts and obtained effect equal to that of tubocurarine in their experiments on the neuromuscular block of gastrocnemius muscle of anaesthetised dogs. A preliminary note on the pharmacological actions of total alkaloids of *Cissampelos pareira* by Roy, Dutta, Ray and Mukherjee¹⁰ mentioned that the alkaloids depressed plain muscle but the duration of action was short; they did not relax voluntary muscles but stimulated the medullary cortex.

Cobra venom :

Suchikabharana, an ayurvedic tonic preparation of cobra venom, was found to have markedly detoxicated during the process of preparation as compared to cobra venom. Roy, Ray, Dutta and Mukherjee¹¹ in investigating its pharmacological properties, found that venom was not absorbed when given orally whereas *suchikabharana* was absorbed and the latter had a direct stimulating effect on the heart and blood vessels while cobra venom stimulated the vasomotor center.

Rindani¹² studied the effect of cobra venom on frog intestine. In fairly high dilutions it caused paralysis of the smooth muscle of the intestine. This paralysis effect was modified by the presence of sympathomimetic and parasympathomimetic substances like adrenaline and acetylcholine. He suggested that the site of action of cobra venom was likely to be on the neuromuscular junction.

Malaria :

An ideal drug for malaria is still to be found, in spite of the claims put forward for the various synthetic drugs now on the market. Chandran *et al*¹³ synthesised 8-guanidine derivatives of 6-methoxy 8-aminoquinoline compound but found no significant

10. Roy, P. K., Dutta, A. J., Ray, G. K. and Mukherjee, B. (1952), Indian J. Med. Res., **40**, 95.

11. Roy, P. K., Ray, G. K., Dutta, A. J. and Mukherjee, B. (1952), *Ibid.*, **40**, 101.

12. Rindani, T. H. (1952), Indian Med. Gaz., **87**, 200.

13. Chandran, K. R., Sen, A. K., Bose, A. N., Ray, N. K. and Basu, U. P. (1952), J. Sci. Ind. Res. India, **11B**, 129.

activity when tested on *P. gallinaceum* in fowls and *P. relictum* infection in sparrows.

Guha and Guha,¹⁴ from amongst the large numbers of substituted guanidine compounds synthesised by them, found, N'-p-chlorophenyl-N'-phenyl-triguanidine-hydrochloride to exhibit slight suppressive activity on *P. gallinaceum* in chicks.

Chatterjee¹⁵ in evaluating the soluble salts of cinchona febrifuge as cheaper substitutes to quinine, found the salts (hydrochloride, hydrobromide, and sulphate) of cinchona febrifuge, i.e., the mother liquor after separation of quinine sulphate, to be fairly satisfactory in treating clinical cases of malaria.

Jaswant Singh, Basu and Ray¹⁶ assessed the prophylactic value of all the well known antimalarials against sporozoite induced *P. gallinaceum* infection in fowls. In a similar experiment, the same authors¹⁷ found that Lapinone exhibited no action on the pre-erythrocytic forms. Jaswant Singh *et al*¹⁸ in their studies on the reactions of blood induced infection in albino mice to Daraprim, found *P. berghei* to be extremely susceptible to the new synthetic antimalarial 2 : 4 diaminopyramidine (Daraprim).

Chaudhari and Chakravarthy,¹⁹ in their clinical trials found that fortnightly doses of camoquin afforded considerable degree of protection from malaria even in the absence of any other measures.

Miscellaneous :

Karunakaran and Pillai,²⁰ in interesting series of experiments concluded that silver, brass and tin coated vessels show bactericidal properties on the organisms present in the stored water of such containers.

14. Guha, S. S. and Guha, P. C. (1952), J. Sci. Ind. Res. India, **11B**, 453.

15. Chatterjee, R. P. (1952), Science and Culture, **17**, 524.

16. Jaswant Singh, Basu, P. C. and Ray, A. P. (1952), Indian J. Malariology, **6**, 123.

17. Ray, A. P., Basu, P. C. and Jayawant Singh, (1952), *Ibid*., **6**, 159.

18. Jaswant Singh, Krishnaswamy, A. K., Satyaprakash., Ray, A. P. and Ramakrishnan, S. P. (1952), *Ibid.*, **6**, 183.

19. Chaudhuri, R. N. and Chakravarthy, N. K. (1952), Indian Med. Gaz., **77**, 453.

20. Karunakaran, C. O. and Pillai, K. V. (1952), Indian Med. Gaz., **87**, 37.

De²¹ devised an apparatus for perfusion of isolated tissues. It is portable, simple, inexpensive and provides continuous aeration instead of oxygenation.

Antia,²² studying the influence of vagotomy on gastric function in dogs, concluded that vagotomy did not abolish but diminished gastric secretion and that response to histamine in one mg./Kg. dose was diminished.

Iswariah and Venkatasubbu studied a group of synthetic 3 methyl iso-quinolines,²³ as also a group of 4-piperidine derivatives,²⁴ for their spasmolytic properties on histamine induced intestinal spasm in dogs and compared the effect with that of papaverine.

Sirsi, Laudon and Werner²⁵ studied the selective action of Diparcol and Myanesin on the tone and reflex regulating centres of the nervous system and concluded that centres of the reticular formation influencing the tone were considerably more susceptible to the paralysing action of internueron blocking drugs, such as Myanesin and Diparcol than the reflex regulating centres.

Singh and Singh²⁶ tried to clarify the position regarding the conflicting reports on the effect of change of temperature on unstriated muscle. The different types of effects produced by temperature, the change in the tonus by cooling, the differential reactions of lactic and alactic tone and the influence of the rate of change of temperature on the reactions were investigated by them and the conclusion arrived at could be regarded as important contributions in this field of study.

The same workers in studying the mode of action of adrenaline on unstriated muscle,²⁷ because, the inhibition produced

21. De, P. (1952), *Indian Med. Gaz.*, **87**, 37.

22. Antia, P. P. (1952), *Indian Physician*, **2**, 178.

23. Iswariah, V. and Venkatasubbu, V. S. (1952), *Current Sci.*, **21**, 131.

24. *Idem*, (1952), *Ibid.*, **21**, 248.

25. Sirsi, M., Laudon, and Werner, G. (1952), *Ibid.*, **21**, 338.

26. Sunita Inderjet Singh and Inderjet Singh, (1952), *Proc. Indian Acad. Sci.*, **35B**, 167.

27. *Idem*, (1952), *Ibid.*, **35B**, 214.

by adrenaline in unstriated muscle may be preceded by a contraction, assumed that inhibition by adrenaline was due to adaptation to excitation and proceeded to try the effect of substances which increased or decreased the adaptation to excitation and inhibition on the adrenaline action.

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28. Pradhan, S. N. (1952), Indian J. Med. Res., **43**, 63. Antihistaminics in ophidiasis.
29. Mukherjee, B., Ghosh, B., Karkun, J. N. and Sadhu, D. P. (1952), *Ibid.*, **40**, 243, 251. Studies on the chromatophorotrophic hormone of the pituitary.
30. Nair, C. P. (1952), Indian Med. Gaz., **87**, 235. Laboratory tests with Kennithal as anaesthetic in monkeys.
31. Jaswant Singh, Raghavan, N. G. S., Misra, B. G., Krishnaswami, A. K. and Roy, A. (1952), *Ibid.*, **87**, 355. Ascaricidal effects of hetrozan.
32. Bose, A. N. and Ghosh, S. (1952), Science and Culture, **18**, 44. Action of vitamin B12 activity in liver extracts.
33. Mohan Rao, V. K., Krishnamurthy, C. R. and Srivastava, D. L. (1952), J. Sci. Ind. Res., India, **11B**, 299. Enzyme inhibitor studies in relation to drug action. Action of certain antibiotics on papain.
34. Gupta, B. and Bal, S. N. (1952), J. Sci. and Ind. Res. India, **11B**, 253. Pharmacology of Indian ephedras.
35. Sunita and Inderjet Singh, (1952), Proc. Indian Acad. Sci., **35B**, 245. Recovery of excitability from inhibition in unstriated muscle.
36. Konar, N. R., Sen Gupta, A. N. and Mitra, S. N. (1952), Indian Med. Gaz., **77**, 498. Intramuscular paraldehyde.
37. Rudra, M. N., Choudhury, L. M. and Sinha, S. P. (1952), Indian Med. Gaz., **77**, 89. Treatment of Lathyrisma with parenteral methionine.
38. Sirsi, M., Kale, L., Natarajan, S. and Nayak, U. G. (1952), J. Indian Inst. Sci., **34**, 261. Studies of the antimicrobial activity and pharmacological properties of some essential oils, extracted from locally cultivated plants.
39. Ramamurthy, V., Ramaswamy, A. S. and De, N. N. (1952), *Ibid.*, **34**, 47. Biological standardisation of digitalis using dogs.
40. Arora, K. L. and Krishnamurthy, C. R., (1952), J. Sci. Ind. Res. India, **11B**, 363. Enzyme Inhibition in relation to drug action: Antibiotics on Amylases.

SOILS AND FERTILISERS

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During recent years, increasing quantities of artificial fertilisers have been used in all the agricultural countries of the world for enhancing crop production. The world consumption of fertilisers has increased enormously, and about 16 million tons of fertilisers are in use.¹ During 1947-50 India imported over 7,71,000 tons of ammonium sulphate from foreign countries costing nearly Rs. 23.5 crores.² The establishment of the Fertiliser Factory at Sindri in Bihar, the biggest of its kind in Asia, is therefore of greatest importance to Indian agriculture. The Factory was formally opened on March 2, 1952. It was recently reported that the production of ammonium sulphate at Sindri in the last quarter 1952-53 was 74,176 tons against the target production of 87,000 tons.

The scope and limitations of sulphate of ammonia as fertiliser in India,³ the relative merits of inorganic fertilisers and organic manures⁴ and related aspects⁵ have naturally been under more active consideration. The publications on these and other aspects of soils and fertilisers during 1952 may be briefly summarised under the following heads.

Soil survey and classification :

Raychaudhuri^{6,7} presented a broad and general picture of the organisation, development and methods of soil survey in other

1. Raychaudhuri, S. P. (1952). Indian J. Agric. Sci., **22**, 223.
2. Vyas, A. R. (1952). Indian Farming, **1** (11), 17.
3. Idnani, M. A. (1952). Science and Culture, **18**, 76.
4. Symposium on Manuring of Crops. (1952). Madras Agric. J., Special Conference Number, **39**, 63.
5. Raychaudhuri, S. P. (1952). Indian Farming, **2** (2), 24.
6. Raychaudhuri, S. P. (1952). Indian J. Agric. Sci., **22**, 247.
7. Raychaudhuri, S. P. (1952). J. Soil Water Conserv. India, **1**, 23.

countries and suggested for India a preliminary rapid reconnaissance survey (a random survey of small areas covering about 2% of the total area) followed by detailed surveys of the areas intended to be developed. On the basis of the texture of surface soils, depth and permeability there would be 48 classes for a soil conservation survey.

In the course of their studies on the saline soils of the Delhi State, Raychaudhuri and Sankaram⁸ observed that the origin of the salts in the profiles of Jumna Khadar area (North) could be traced to the upward movement of the underground water, the salt composition of which was more or less similar to that of the soil water extracts. Such areas could be reclaimed either by cultural methods like drainage practised alone or with sulphur. Desai and Sen⁹ examined a large number of normal agricultural soils, both virgin and cultivated, for their sodium chloride contents. They observed that the NaCl contents of the soils decreased as the annual rainfall of the localities and their distances from the nearest sea-board increased.

The potash availabilities in the Indian soils¹⁰ were related to their geological origin. Gangetic alluvium and those soils bordering the Vindhyan system were found to have generally low K-availability or high fixation capacity, while soils of the crystalline gneiss or coastal alluvium bordering cretaceous or the Gondwana systems had high availability or low K-fixation capacity.

Banerjee¹¹ drew attention to the deposit of gypsum (roughly 105,000 tons) near Garur Chatti on the south bank of the river Ganges. He also pointed out the difficulty of accessibility to the area and transport of the material.

The Bihar soils were divided into 148 different broad soil types, on which manurial experiments were carried out.¹²

8. Raychaudhuri, S. P. and Sankaram, A. (1952), Indian J. Agric. Sci., **22**, 209.

9. Desai, S. V. and Sen, A. (1952), *Ibid.*, **22**, 63.

10. Ramamoorthy, B., Desai, S. V. and Raychaudhuri, S. P. (1952), Indian J. Agric. Sci., **22**, 49.

11. Banerjee, A. K. (1952), Current Science, **21**, 275.

12. Indian Farming, (1952), **1** (10), 9.

Krishnaswamy and Gupta¹³ made a preliminary study of the topographic features and vegetation of the Rajputana Desert soils. Chemical analysis of the soils showed that they did not contain salts in quantities toxic to plant growth.

A proper soil survey of the land would be useful in the economic use of fertilisers, such as phosphatic fertilisers.¹⁴ Attention was also drawn to the fertilising influence of rainfall¹⁵ and to the geographical regional approach (with due consideration of the social and economic condition of the region) in the planning of land use.¹⁶

Soil erosion and its control :

The moisture and soil conservation problems of the dry regions of Bombay State were considered by Basu.¹⁷ A random erosion survey revealed that in the Deccan and Karnatak zones 69% and 73% respectively of the total area were severely eroded. Direct measurement of erosion and run off indicated losses of 24-37 tons of soil per acre annually under cereal cropping as against less than 2 tons under spreading varieties of legumes. An estimate of the losses of N and P₂O₅ over 5.4 million acres of winter cereals showed that about 300,000 lbs. of these constituents were lost annually.

Basu and Puranik¹⁸ collected information on the river basins of the Bombay-Deccan and Karnatak regions in relation to soil erosion, rainfall and slope conditions.

Kudzu vine (*Pueraria hirsuta* Scheid syn. *P. thunbergiana*) is extensively used in the U.S.A. as a fodder *cum* soil-conservation crop. The vine makes an excellent growth on light soil of poor fertility. The areas suitable for successful introduction of the

13. Krishnaswamy, V. S. and Gupta, R. S. (1952). Indian Forester, **78**, 595.

14. Gadre, G. T. and Gupta, J. (1952). Science and Culture, **18**, 165.

15. Balasubramaniam, C. and Jayaraman, N. V. (1952). Madras Agric. J., **39**, 519.

16. Tamhane, R. V. (1952). Science and Culture, **18**, 272.

17. Basu, J. K. (1952). Emp. J. Exptl. Agric., **20**, 326.

18. Basu, J. K. and Puranik, N. B. (1952). J. Soil Water Conserv. India, **1**, 11.

vine are the north-west drier tracts which have been subjected to very serious type of erosion; a vigorous growing plant like Kudzu vine would reclaim the area thoroughly and quickly and at the same time would improve the fodder resources of these tracts.¹⁹

An account of the observations at the Viswa Bharati Soil Erosion Research Station, Shantiniketan was given, indicating also the possible use of Kudzu vine for binding the badly eroded soil and as a useful fodder.²⁰

Physical and physico-chemical properties of soil :

Das, Rao and Tamhane²¹ studied the electro-chemical properties of hydrogen clays from contiguous black and red soils from Bhopal and found that the black soils on continued weathering gave rise to the brown, yellow and red soils, the montmorillonites decomposing into kaolinites during the weathering process.

Mitra and Rajagopalan,²² from the electrometric titration curves of the different clay minerals, found illite showing features similar to muscovite, particularly in the KOH curve of the acid system. There were characteristic inflexions in the curves in the neighbourhood of pH 5.5 and particularly pH 7.5 and 11.0, and the cation exchange capacity measured at the second and third inflexions were in both clays as 3 : 1, giving for illite values of 60 and 20 m.e. for 100 g. They²³ further reported that the negative (surface) charge of a clay crystal responsible for the base exchange capacity was caused partly by iso-morphous replacements within the lattice and partly by dissociation of the available OH group of the crystal.

Dayal and Hendricks,²⁴ using the amount of ethylene glycol retention as an index of inter-layer swelling, reported that potassium

19. Dabaghao, P. M. and Gandhi, R. T. (1952), Indian J. Agric. Sci., **22**, 279.

20. Indian Farming, (1952), **2** (2), 16.

21. Das, S. C., Rao, A. and Tamhane, R. V. (1952), Current Science, **21**, 245.

22. Mitra, R. P. and Rajagopalan, K. S. (1952), J. Soil Sci., **3**, 34.

23. *Idem*, (1952), Soil Sci., **73**, 349.

24. Dayal, R. S. and Hendricks, S. B. (1952), Proc. Soil Sci. Soc. Amer., **16**, 45.

montmorillonite dried at 100°C. showed marked lowering of glycol retention than Ca and H montmorillonites. X-ray diffraction data indicated that these potassium clays were in part unsolvated between silicon layers and in part solvated with two layers of ethylene glycol. Electrodialysis method with Marsden cell was employed by Agarwal and Pollard²⁵ for distinguishing potassium in the exchangeable and non-exchangeable or fixed forms. Leaching with 1N ammonium acetate removed about the same amounts of potassium from variously treated potassium hydrogen clays as did electrodialysis for 1 hour. A more prolonged electrodialysis (2 hrs.) removed more potassium than the leaching, suggesting that the additional potassium was derived from fixed forms. There was evidence that the rate of release of fixed potassium might be related to the ease with which it might become available in the soil.

Pant, Kumar and Shukla²⁶ studied the influence of electric current on the physical properties of typical clays of Uttar Pradesh and on the chemical changes brought about in the clays. Pant and Shukla²⁷ in a study of some typical Indian soils found that base-exchange capacity and Si/Al ratio had a pronounced effect on soil properties. These together with dehydration, titration acidity and swelling characteristics indicated the type of clay mineral that predominated in the soil.

From laboratory investigations on three soils, Bharghava and Shukla²⁸ determined capillary ascent of water and moisture content at regular depths after 1, 2, 8 and 11 days. These were plotted on graphs from which the moisture contents at different depths and on different days could be predicted with an accuracy of 2% in heavy clays.

Rao and Wadhawan²⁹ studied the effect of temperature of dehydration of the Gangetic alluvial soils of Delhi on the permeability changes with time. Low temperatures of hydration, e.g. 60°C. brought about only the shrinkage of the soil reducing the

25. Agarwal, B. R. and Pollard, A. G. (1952), *J. Sci. Food Agric.*, **3**, 152.

26. Pant, C. M., Kumar, A. and Shukla, K. P. (1952), *Uttar Prad. Irrig. Res. Inst. Rept.*, 159.

27. Pant, C. M. and Shukla, K. P. (1952), *Ibid.*, 164.

28. Bharghava, D. N. and Shukla, K. P. (1952), *Ibid.*, 217.

29. Rao, K. S. and Wadhawan, S. K. (1952), *Current Science*, **21**, 100.

porosity whereas high temperatures upto 650°C. brought about aggregation of the smaller soil particles into bigger aggregates; above 650°C. the soil seemed to suffer an incipient fusion resulting in a decrease of porosity.

An attempt was made by Sen and Manohar Lal³⁰ to see if any definite pF value can be assigned to the liquid limit of soils as determined by the A. S. T. M. method. A large number of soils ranging in texture from loams to heavy clays of Uttar Pradesh were examined and suction-moisture curves in the wet range were obtained by means of Puri's capillarimeter. From such curves it was inferred that the pF value of the soils at the liquid limit was approximately 2.2.

The potentiometric titration of the soils from an usar profile was studied by Mukerji.³¹ The initial and subsequent effects of various amounts of sulphuric acid on the pH of the soil suspensions were given. The pH of the suspensions brought to approximately neutrality increased on standing, the increase decreasing with depth at which the soil was sampled.

An improved method of determination of the lime requirement of soils was worked out by Patel and Truog.³² In this method a sample of soil was treated with a measured amount of calcium bicarbonate in excess of that required for neutralisation. After two evaporation to dryness, the calcium carbonate formed from the excess was determined by a calcimeter, the amount of lime required for neutralisation being calculated from the carbon dioxide volumes evolved in a blank determination and in the test with a soil sample. Results obtained by this method on different soils were in good agreement with lime requirements found in field experiments.

A mechanical appliance for the aggregate analysis of soils was devised by Singh³³ using a sieving machine with provision for the reciprocating movement of a lift to raise and lower a series of sieves for dry and wet sieving. Using such a portable machine, which

30. Sen, B. R. and Manohar Lal, (1952), J. Sci. and Indust. Res. India, **11B**, 451.

31. Mukerji, S. K. (1952), Agric. Animal Husbandry, U. P., **6**, Sec. 3.

32. Patel, D. K. and Truog, E. (1952), Proc. Soil Sci. Soc. Amer., **16**, 44.

33. Singh, K. (1952), J. Sci. Food Agric., **3**, 205.

could be worked on the field with an accumulator, a study on the stability of the aggregates of a soil was made.

Singh³⁴ also devised an automatic leaching apparatus for washing soils and precipitates, which he used both for continuous and intermittent washings. An essential part of the apparatus was an auto-irrigator, delivery of water from which was set to lag behind the draining off of the filtrate. With a set of 24 units, the apparatus was claimed to be capable of leaching 72 soil samples in 9 hours.

Dakshinamurthi³⁵ studied the role of ionic diffusion in the extraction of soil solutions and observed that in soils of uniform packing with fine capillary pores, it was possible to have velocities of flow much higher than those used in the capillaries studied.

Carbon and nitrogen changes in soil:

Ram and Bhattacharya³⁶ investigated the soil organic matter with particular reference to the soil hydrolysates of Agra soils and reported that the soil organic matter was so firmly bound up with the inorganic constituents, particularly Ca, that it was difficult to isolate even a very small quantity of the hydrolysed fraction of the organic matter in a state absolutely free from the inorganic constituents.

In order to judge the nitrifying capacity of soils and their "fertility index" Bharucha and Sheriar³⁷ suggested that all the three products of nitrification, viz., ammonia, nitrite and nitrate nitrogen, might be estimated at short intervals. Desai and Subbiah³⁸ recommended a rapid chemical method for testing the availability of nitrogen in soils and manures. The nitrifiable N was compared with 80% sulphuric-hydrolysable N and the nitrifiability was of the same order as the sulphuric-hydrolysable N.

Soil microbiology:

Pathak and Shrikhande³⁹ studied the nitrifying capacity of

34. Singh, K. (1952), *J. Sci. Food Agric.*, **3**, 210.

35. Dakshinamurthi, C. (1952), *Proc. Indian Acad. Sci.*, **35A**, 314.

36. Ram, N. and Battacharya, A. K. (1952), *Indian J. Agric. Sci.*, **22**, 235.

37. Bharucha, F. R. and Sheriar, K. C. (1952), *Proc. Indian Acad. Sci.*, **35B**, 28.

38. Desai, S. V. and Subbiah, B. V. (1952), *Indian J. Agric. Sci.*, **22**, 167.

39. Pathak, A. N. and Shrikhande, J. G. (1952), *Current Science*, **21**, 13.

the different fractions of the manured and unmanured soils, *viz.*, clay, silt and sand, as affected by continuous cropping of wheat and observed that all the three mechanical fractions from the unmanured plot promoted nitrification to a greater extent than the corresponding fractions from the manured plot, clay possessing greater nitrifying capacity than silt and sand in both the soils. The surface soil indicated higher activity in both the plots.

Bhide, Moniz and Patil ⁴⁰ made 61 cultures of actinomycetes from Karnatak soils, and 7 of these cultures were found antibiotic to three or more species of plant pathogenic *Xanthomonas*.

Bose ⁴¹ isolated four species of *Aspergillus*, one of *Fusarium*, *Trichoderma viride* and *Paecilomyces varioti* from jute incubated with soil. Of these, two *Aspergillus* sp. and the *Fusarium* sp. had marked cellulose-decomposing power. *Chaetomium* and *Penicillium* species and some fungi of the *Dematiaceae* family, which strongly attack jute under other conditions, were suppressed in soil.

Prakash and Saksena ⁴² studied the aerobic decomposition of paddy and bajra straws by 22 fungi isolated from Allahabad soils. The decomposition was studied by determining the CO_2 and NH_3 evolution, loss in weight and loss in total amount of carbon during a seven-day period. There was no uniformity in the rates of decomposition by various fungi, but there was a fair amount of correlation between the total carbon decomposed and the total loss in weight of the straw. All the 22 fungi behaved similarly towards paddy and bajra straws.

Sulochana ⁴³ studied the effect of certain micro-elements (Al, B, Co, Mn, Mo, Ni and Zn) in concentrations ranging from 50 to 400 p. p. m. on soil bacteria, actinomycetes and fungi in soil. The bacterial numbers increased enormously in the soils treated with Mn. This was closely followed by B, and by Zn, Mo and Li to a lesser extent. Ni, Al and Co exerted an adverse

40. Bhide, V. P., Moniz, L. and Patil, R. B. (1952), Current Science, **21**, 70.

41. Bose, R. G. (1952), J. Sci. and Indust. Res. India, **11B**, 250.

42. Prakash, R. and Saksena, R. K. (1952), Proc. Indian Acad. Sci. **36B**, 119.

43. Sulochana, C. B. (1952), *Itid.*, **36B**, 19.

influence on the bacterial population of the soil. The numbers of actinomycetes and fungi were greatly increased by Li, and to a lesser degree by Mn, B, Mo, Co and Al, at concentrations of 100—200 p.p.m. She⁴⁴ also studied the effects of micro-element amendments on the saprophytic habits of *Fusaria*. In all the series of micro-element amendments, the extent and progress of colonisation by species of *Fusarium* were observed to be markedly diminished, whereas in the unamended control there was 100% colonisation.

Joshi and Kelkar⁴⁵ reported that earthworms had a beneficial effect on the yields of crops, e.g. wheat and jowar. The earthworm casts not only contained higher amounts of nitrate-N at the start but they also possessed a greater nitrifying power than the corresponding soils.

Minor elements in plant nutrition:

The influence of Zn on tomato fruits was studied : the maximum yield was obtained with 2 p.p.m. of Zn ; the ascorbic acid content normally increased with increasing availability of Zn and also with the ripening of fruit from green to red, the maximum amount occurring in the fully ripened fruit ; and the total carbohydrate content showed a decrease with increasing availability of Zn and with the ripening of the fruit.⁴⁶

In a study of the relation of N supply to Mo requirement of cauliflower grown in sand culture, Agarwala⁴⁷ observed a most striking effect of nitrite ; this compound showed the lowest Mo requirement with respect to growth, ascorbic acid status and freedom from whiptail.

In an experiment⁴⁸ conducted to study the response of cotton plants to micro element soil amendments, Zn and Mn were found to be beneficial for the growth of cotton plants. B, Li and Mo were toxic. Studies on the pathogenic potentialities of *Fusarium vasinfectum* on susceptible variety of cotton showed that Zn was

44. Sulochana, C. B. (1952), Proc. Indian Acad. Sci., **35B**, 209.

45. Joshi, N. V. and Kelkar, B. V. (1952), Indian J. Agric. Sci., **22**, 180.

46. Govindan, P. R. (1952), Current Science, **21**, 15.

47. Agarwala, S. C. (1952), Nature, **169**, 1099.

48. Sulochana, C. B. (1952), Proc. Indian Acad. Sci., **36B**, 234.

effective in reducing the wilt incidence, whereas Mn aggravated it. The percentage germination⁴⁹ of the conidia of *Fusarium vasinfectum* in all the soil samples amended with micro-elements, except Mn 50 p.p.m., was much lower than that of the un-amended control soil. Zn, Mo, Li, Al, Ni, B, Co and Mn were correspondingly inhibitive in the order mentioned.

Relative merits of organic manures and inorganic fertilisers :

The results of more than 5,000 manurial experiments carried out during the past 40 years at more than 100 Experimental Stations distributed in all the provinces of India were examined with a view to studying the performance of 11 different manures and fertilisers individually and in combinations on 7 important cereal crops and on sugarcane and potatoes.⁵⁰ In India as a whole, the organic manures (farmyard manure, green manure, oil-cakes, bone meal and fish manure) individually or in combinations were in every case 2 to 3 times as effective as artificial fertilisers (ammonium sulphate, sodium or potassium nitrate, superphosphate, Niciphos and potassic manures). Organics *plus* artificials were intermediate (except in the case of paddy, in which they gave maximum percentage increases in yield over 'no manure'). Artificials left undesirable residual effects on the crop yields and on soil composition and structure in contrast to the beneficial residual effects of organics on the crop yields and on soil structure.

Taking the N recovery as the criterion of relative efficiency, amongst the organic manures tried (farmyard manure, activated sludge and rape cake), rape cake proved to be the best manure for wheat (Rabi) while activated sludge generally gave higher N recoveries for Kharif crops like jowar and maize. The phosphate recovery was also highest in the case of rape cake treatment. Combination of organic and inorganic N along with phosphate gave good recoveries of N for all crops (except maize) and during all the years ; phosphate recovery was also good with this combination in the case of wheat crop. Complete artificials comprising of nitrogen, phosphate and potash gave good nitrogen recoveries in the begin-

49. Sulochana, C. B. (1952), Proc Indian Acad. Sci., **36B**, 229.

50. Bhushanam, K. (1952), Madras Agric. J., **39**, 148.

ning of the experiment, but year after year the nitrogen recovery decreased.⁵¹

A combination of green manure and ammonium sulphate and superphosphate or application of Niciphos in conjunction with green manure was recommended for paddy.⁵² There was a distinct superiority in the humus and nitrogen contents of soils which received compost as basal dressing for sugarcane.⁵³ In regard to cotton cultivation in Bombay Karnatak, it was observed that the crop did not respond much to the application of farmyard manure alone and that it responded less to the application of groundnut cake than to ammonium nitrate.⁵⁴ Ammonium sulphate and groundnut cake were considered as the efficient sources of nitrogen for cotton ; ammonium sulphate might be safely used without fear of adverse effect on the crop or the soil ; for the proper use of this fertiliser, a plentiful supply of lime is necessary and the cotton soils contain large reserves of it.⁵⁵

Influence of manures and fertilisers on the quality of crops :

In a comparative study of rice grown under manorial treatments it was shown that rice manured with green manure was of superior quality as judged by the granular make-up of the rice starch and the feeding values of rice and straw, to that fertilised with ammonium sulphate. The rice grown on ammonium sulphate was even inferior in quality to that grown unmanured.⁵⁶

Sathe and Venkitasubramanian⁵⁷ reported that the total phosphorus content of rice varied according to the phosphorus added to the soil ; that addition of nitrogen did not have a predominant effect on the phosphorus content, but the trend was for

51. Desai, S. V. and Subbiah, B. V. (1952), Proc. Indian Acad. Sci., **36B**, 181.

52. Raju, M. S. (1952), *Madras Agric. J.*, **39**, 130.

53. Lakshmikanthan, M. (1952), *Ibid.*, **39**, 130.

54. Tippannavar, M. B. and Patil, S. V. (1952), *Indian Cott. Grow. Rev.*, **6**, 26.

55. Panse, V. G. and Mokashi, V. K. (1952), *Ibid.*, **6**, 61.

56. Verghese, E. J. (1952), *Madras Agric. J.*, **39**, 256.

57. Sathe, V. and Venkitasubramanian, T. A. (1952), *Science and Culture*, **17**, 303.

a decrease in the phosphorus content ; and that potassium did not seem to have any effect on the phosphorus content of the rice. These observations are similar to those of S. P. Aiyar (*Proc. Indian Acad. Sci.*, 1946, **23B**, 165).

Esh and Basu⁵⁸ examined a sample of wheat from a crop which gave an unusually high yield (37 mds./acre) and compared its nutritive value with that of an average wheat in order to find whether or not a high productivity resulted in a higher nutrient level. The chemical composition of the test sample did not differ much from that of an average wheat. The sample tended to contain a little more protein and Ca but a little less P ; the thiamine content was almost the same. The biological assay showed that the protein utilisation, 'Protein Efficiency Ratio' or the protein quality did not change significantly due to high productivity.

Legumes and nitrogen status of soil :

Desai and Sen⁵⁹ reported the results of drain-gauge experiments conducted at Pusa (Bihar) for 30 years, which showed that the growth of a legume, such as sunn-hemp, did not improve the N status of the soil, if the over-ground parts of the legume were cut and removed. Acharya, Jain and Jha⁶⁰ showed that when the berseem crop was included in the rotation, the soil was improved both chemically and microbiologically ; and this in turn led to a high fertility level as indicated by the greater yields of wheat obtained on the berseem-grown soils, as compared to the 'no berseem' plots. Raheja and Obhrai⁶¹ adduced evidence that growing of suitable legumes as 'catch crops' between two main crops was useful in preserving soil fertility and in augmenting production and annual net income per acre. Acharya recommended berseem as a suitable rotation crop.⁶²

- 58. Esh, G. C. and Basu, U. P. (1952), *Indian J. Agric. Sci.*, **22**, 275.
- 59. Desai, S. V. and Sen, A. (1952), *Science and Culture*, **17**, 323.
- 60. Acharya, C. N., Jain, S. P. and Jha, J. (1952), *Ibid.*, **18**, 286.
- 61. Raheja, P. C. and Obhrai, S. R. (1952), *Indian Farming*, **2** (6), 16.
- 62. Acharya, C. N. (1952), *Ibid.*, **2** (7), 12

In a study of the role of legumes and green manuring in mixed farming holdings, Sen and Bains⁶³ recorded that the yields of wheat and barley obtained from green manured holdings were substantially higher than those obtained from the holdings where fallowing and growing legumes were practised. They⁶⁴ also studied the effect of phosphate manuring with and without potash on the yield and quality of berseem fodder, and reported that the quality of fodder showed marked improvement in respect of phosphate content and slight improvement in respect of Ca content by phosphate manuring.

With regard to residual effect of phosphate applied to previous legumes on the succeeding cotton crop,⁶⁵ it was found that in poor field there was significant increase in the yield of cotton while in rich field the increase in yield was not significant. Amongst different legumes, groundnut and cowpea, which are shallow rooted, gave increased yields of cotton on both rich and poor soils due to the residual effect of phosphate. Direct application of N to cotton increased the yield significantly. Dabaghao, Sen and Bains⁶⁶ found in their 'ley * farming experiment' that application of superphosphate alone and in combination with ammonium sulphate, or of ammonium phosphate to the ley, significantly increased the yields and improved the quality of Rhodes grass-lucerne.

Green manure:

Assuming that the N supply for a single crop like paddy is divided equally between the five sources, viz., bone meal, oil-cakes, sulphate of ammonia, farmyard manure and green manure, with N percentages of 4, 5, 20, 0.5 and 0.7 respectively, it was estimated that about

* The ley consists of two complementary crops, viz., a grass and a legume. The former has the valuable quality of improving the soil structure and when grown in association with a legume, the latter enriches the N content of the soil by the activity of its nodule organisms. The association also affords a highly nutritious fodder for cattle.

63. Sen, S. and Bains, S. S. (1952), Indian J. Agric. Sci., **22**, 33.

64. *Idem*, (1952), *Ibid.*, **22**, 257.

65. Bhide, N. N. (1952), Indian Cott. Grow. Rev., **6**, 187.

66. Dabaghao, P. M., Sen, S. and Bains, S. S. (1952), Indian J. Agric. Sci., **22**, 175.

3 million tons of bone meal, 2.4 million tons of oil-cakes, 0.6 million tons of sulphate of ammonia, 24 million tons of farmyard manure and 17 million tons of green manure would be required to supply 60 million acres of paddy land at a minimum dose of 20 lbs. N per acre.⁶⁷

The effect of sann green manure on the fibre and agronomic characters of cotton⁶⁸ and various other aspects of green manuring were considered.⁶⁹⁻⁷⁰

Cultural operations :

Kahn and Mathur⁷¹ reported the results of their studies with wheat in regard to the depth of ploughing and frequency of cultivation: shallow ploughing (4 to 5 inches) as obtained by 'country' plough was the most practicable depth to plough; deep ploughing did not pay; and the best results were obtained from the plots which received 9 cultivations. Timely cultivation, and not frequent cultivation, should be the ideal. The influence of soil cultivation on the growth and yield of winter wheat was studied by Singh.⁷² He compared the effect of 8 in. ploughing and of 2 and 4 in. tine cultivations on 9 soils of differing texture. Shallow cultivation produced the greatest compactness and consequently the highest moisture content and temperature in the soil, also the greatest degree of tillering: but on 2 soils the tiller mortality was highest on shallow cultivated plots, possibly due to N deficiency. The dominant factor in the spacing effect was the initial stand. Singh⁷³ also studied the effects of various types of soil preparations during 3 seasons. In open textured and light soils the winter survival in mild season was better in plots ploughed to 8" or cultivated 3"-4" deep than in those cultivated 1½"-2" deep only; the reverse was true during a severe winter.

- 67. Rao, W. V. B. S. and Ghosh, A. S. (1952), *Science and Culture*, **18**, 170.
- 68. Nayak, H. R. (1952), *Indian Cott. Grow. Rev.*, **6**, 22.
- 69. Raheja, P. C. (1952), *Indian Farming*, **2** (2), 28.
- 70. Khan, A. R. (1952), *Ibid.*, **2** (3), 8.
- 71. Khan, A. R. and Mathur B. P. (1952), *Ibid.*, **2** (9), 14.
- 72. Singh, K. (1952), *J. Sci. Food Agric.*, **3**, 354.
- 73. *Idem*, (1952), *Ibid.*, **3**, 256.

Nayak⁷⁴ observed that 'no ploughing' did not produce any significant effect on the fibre properties as well as on the ginning percentage and yield per acre of cotton. Raheja and Singh⁷⁵ studied tillering in relation to sugarcane weight and stressed the importance of increased tillering for appreciating the tonnage of the crop.

It was observed that a period of preliminary continued darkness had a very marked effect upon the percentage of germination of the seeds of *Anisochilus eriocephalus* Benth, which increased first with the increase in the 'dark period', reached a maximum of 13.4% for 7 days and then fell sharply almost to zero on the 12th day.⁷⁶

Verma⁷⁷ suggested a simple device for the placement of phosphatic fertilisers. Govinda Rajan and Rao also suggested an improved method of phosphate application.⁷⁸ Panikkar⁷⁹ made suggestions in regard to dry farming methods. Khan, Parr and Roy⁸⁰ presented data relating to cultivation operations and worked out the operating cost of a farm tractor at Karnal.

Farm refuse and domestic wastes for manurial purposes.

Acharya⁸¹ gave an account of certain aspects of preparation and utilisation of compost. Idnani⁸² dealt with some methods of controlling fly breeding on compost heaps.

Reference was made to the schemes of sewage farming at certain centres and further possibilities of utilising sewage for crop production were indicated.⁸³

- 74. Nayak, H. R. (1952), Indian Cott. Grow. Rev., **6**, 156.
- 75. Raheja, P. C. and Singh, D. (1952), Indian J. Agric. Sci., **22**, 139.
- 76. Bakshi, T. S (1952), Current Science, **21**, 108.
- 77. Verma, R. D. (1952), Indian Farming, **2** (4), 27.
- 78. Govinda Rajan, S. V. and Rao, B. V. V. (1952), Mysore Agric. J., **28**, 77.
- 79. Panikkar, M. R. (1952), Indian Farming, **1** (12), 26.
- 80. Khan, A. R., Parr, C. H. and Roy, S. K. (1952), Indian J. Agric. Sci., **22**, 293.
- 81. Acharya, C. N. (1952), Indian Farming, **2** (4), 23.
- 82. Idnani, M. A. (1952), *Ibid.*, **2** (9), 30.
- 83. Singh, S. D. (1952), *Ibid.*, **1** (11), 20.

Manurial practice and crop production :

Vachhani⁸⁴ found that ammonium sulphate was the most satisfactory fertiliser for the rice crop and recommended its application for stepping up rice production. Other practical aspects of increasing the yields of paddy were considered,^{85,86} and trials with Chinese varieties of paddy were conducted.⁸⁷ At the Rice Experimental Area, Sabour, it was observed that the best ratoon yield of 505 lbs. per acre, which was about 31% of the yield of the main crop, was obtained from the area where the crop was harvested at half the height.⁸⁸

Hora⁸⁹ indicated the possibilities of paddy-cum-fish culture, which would be of special value in 24-parganas of West Bengal. Growing of fish in paddy fields might confer additional benefits by controlling the breeding of mosquitoes and thereby reducing the incidence of malaria.

Iyer *et al*⁹⁰ gave evidence that as a result of impounding the waste waters from a tannery close to paddy fields, the salts and toxic substances from the waste material soaked through the soil and adversely affected the composition of the soil in the paddy fields and the growth of the crop.

The absorption of N and P by the wheat was studied by Desai and Subbiah.⁹¹ Field trials showed that the absorption by plants of N and P was governed by the relative availability of the nutrients at the time of growth, and that fallowing increased the uptake of N at the expense of P. The effect of application of N during different periods of growth of wheat was studied by Singh.⁹² Best results were obtained by applying N in two instalments, one at germination 12 days after sowing and the other

- 84. Vachhani, M. V. (1952), *Indian Farming*, **2** (1), 28.
- 85. Gupta, Y. C. (1952), *Ibid.*, **1** (12), 10.
- 86. Chandani, J. J. (1952), *Ibid.*, **2** (1), 8.
- 87. Chatterji, U. N. (1952), *Ibid.*, **2** (7), 22.
- 88. Saran, A. B. and Prasad, M. (1952), *Current Science*, **21**, 224.
- 89. Hora, S. L. (1952), *Ibid.*, **21**, 138.
- 90. Iyer, C. R. H., Rajagopalan, R. and Pillai, S. C. (1952), *J. Indian Inst. Sci.*, **34**, 163.
- 91. Subbiah, B. V. and Desai, S. V. (1952), *Current Science*, **21**, 100.
- 92. Singh, R. P. (1952), *Allahabad Farmer*, **26**, 87.

at tillering 30 days after sowing. A single application at flowering time was found useless, and division of the doses into three, one at germination, and the others at tillering and flowering did not give good results. Observations on the improved varieties of hill wheats,⁹³ on certain practical aspects of wheat and barley,⁹⁴ on hot weather bajri,⁹⁵ and in regard to pre-monsoon sowing of jowar⁹⁶ were also made.

Increasing doses of N were found to increase the concentration of this element in the sugarcane tissue, but the effect was not much over 100 lbs. N; the concentration showed a downward trend with age.⁹⁷ Ratooning of sugarcane for one year under average management, cultivation and manuring was found very useful to the growers as well as to the sugar industry in Uttar Pradesh; longer ratoons than one year were discouraged.⁹⁸ Observations on other practical aspects on sugarcane were also made.⁹⁹⁻¹⁰²

Methods of increasing potato yields in Bihar were suggested.¹⁰³ An account of the groundnut crop with special reference to Madras was given.¹⁰⁴ The effect of groundnut cake on the quality and agronomical characters of cotton was studied,¹⁰⁵ and some points of practical interest to cotton growers were considered.¹⁰⁶ Practical aspects of other industrial crops, such as jute¹⁰⁷ and coconut,^{108,109} were also presented.

93. Kohli, S. P. and Patkar, M. B. (1952), *Indian Farming*, **2** (6), 26.
94. Sen, S. (1952), *Ibid.*, **2** (5), 8.
95. Desai, H. M. (1952), *Ibid.*, **2** (8), 18.
96. Galande, N. K. and Wa Kankar, S. M. (1952), *Ibid.*, **2** (2), 18.
97. Rao, M. V. M. and Narasimham, R. L. (1952), *Madras Agric. J.*, **39**, 255.
98. Mukerji, B. K. (1952), *Indian J. Agric. Sci.*, **22**, 267.
99. Bose, R. D. (1952), *Indian Farming*, **1** (11), 26.
100. Reddi, K. R. (1952), *Ibid.*, **2** (2), 20.
101. Raghavan, T. S. (1952), *Ibid.*, **2** (3), 20.
102. Raheja, P. C. (1952), *Ibid.*, **2** (9), 8.
103. Pushkarnath and Patel, J. S. (1952), *Ibid.*, **2** (4), 18.
104. Venkatanarayana, G. (1952), *Madras Agric. J.*, **39**, 317.
105. Nayak, H. R. (1952), *Indian Cott. Grow. Rev.*, **6**, 76.
106. Chandnani, J. J. (1952), *Indian Farming*, **2** (2), 8.
107. Chandoani, J. J. and Chatterjee, D. (1952), *Ibid.*, **2** (1), 16.
108. Gopalan, K. (1952), *Ibid.*, **2** (1), 10.
109. *Idem.* (1952), *Ibid.*, **2** (7), 20.

Mallik and De¹¹⁰ carried out studies on the manuring of mango, which showed that application of N led to increased growth. P and K produced little effect. Maximum effect was obtained with N, P and K. Bajawa and Kaura¹¹¹ reported that the average yields of oranges compared favourably with those in other countries. Field trials over a period of 4 years showed that application of 100-130 lbs. of farmyard manure, together with 2.2-3.2 lbs. of ammonium sulphate, per tree led to increases in yield upto 60.5%. Information on the production of other fruits, such as plantains¹¹² and papaya,¹¹³ was also given.

Science and improvement of agriculture :

Our knowledge of the soil processes and of the conditions for producing consistently increased crop yields is still inadequate. At the same time, useful advances are being made, e.g. the introduction of 'Krilium' for improving the mechanical structure of soils and of the tracer technique in agriculture, and it is increasingly realised that agricultural science has a broader basis and a more complicated structure than any other science.

"For our immediate programme, the existing knowledge has to be utilized. It descends from three sources: that of the efficient farmer, that of the experimental stations and that of other countries which we can justifiably use irrespective of differences in conditions. It is desirable to work out recommendations crop by crop and soil by soil for advisory work. Loose recommendations are of little value."¹¹⁴

110. Mallik, P. C. and De, B. N. (1952). Indian J. Agric. Sci., **22**, 151.

111. Bajawa, B. S. and Kaura, N. R. (1952). Indian J. Hort., **9**, 29.

112. Choudhri, B. L. (1952). Indian Farming, **2** (3), 12.

113. Nath, J. (1952). *Ibid.*, **2** (3), 26.

114. Mukherjee, J. N. (1952). Proc. 39th Indian Science Congress, Calcutta, Part II, Presidential Addresses, p. 29.

PLANT PHYSIOLOGY

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The investigations deal mainly with problems of mineral nutrition, metabolism, developmental physiology, growth regulators and plant movements.

Mineral Nutrition:

Govindan¹ found that yield of tomato was substantially increased by boron within the range, 0.5 to 3 p.p.m. In regard to the effect of zinc the same author² found that concentrations upto 2 p.p.m. increased the yield of tomato whereas beyond this level it had a depressing effect.

Joshi and Joshi³ reported that addition of copper sulphate at the rate of one lb. per acre to paddy soils substantially increased the yield of paddy in the Konkan tract.

Lal and Tyagi⁴ described the effects of nitrogen, phosphorus and potassium on the growth and pigment content of tobacco grown under pot-culture (sand as well as soil). In the sand culture effects of omission of N, P and K and under soil culture effects of all the 8 combinations of N, P and K were studied. Under soil culture the following observations were made: Nitrogen increased height, leaf number as well as size, and chlorophyll a and b; colour of cured leaf was poor and flowering was delayed. Phosphorus increased height during a later stage, increased chlorophyll a and its ratio to xanthophyll. Potassium decreased chlorophyll a and b and carotene; leaf colour during curing was improved. Due to deficiency of nitrogen, vegetative vigour, weight of component parts, and content of chlorophyll a and b were reduced; flowering was also inhibited. The effects of phosphorus deficiency were more or less similar to those of nitrogen deficiency, the intensity of effects being comparatively less in the former; flowering was

1. Govindan, P. R. (1952), *Current Science*, **20**, 14.

2. *Idem*, (1952), *Ibid.*, **20**, 15.

3. Joshi, N. V. and Joshi, S. G. (1952), *Science and Culture*, **18**, 96.

4. Lal, K. N. and Tyagi, R. S. (1952), *J. Indian Bot. Soc.*, **31**, 69.

completely suppressed. Omission of potassium inhibited flowering partially and reduced vegetative growth slightly.

Lal, Rao and De⁶ found that nitrogen was relatively more effective in increasing chlorophyll content of sugarcane leaves than either phosphorus or potassium.

Dastur and Gopani⁶ investigated the effect of spacing on the growth and yield of cotton in south Gujarat (Surat). Formerly cotton was drilled 2' apart but by 1923-24 it was dibbled at 3' \times 3'. In 1932, cultivators started sowing cotton 4, 5 and even 6 ft. apart between rows and thinned to 1 to 1½ ft. as they thought wider spacing improved yield. The cotton soils of south Gujarat are black and clayey, four to six feet in depth. The authors found that under close spacing the yield of seed cotton decreased due to suppression in the extension as well as reproductive growth, although the total dry matter per unit area was higher than that under wider spacing. At all spacings, application of N upto 75 lb. per acre benefited yield but at a still higher level of N the yields tended to be equal under close, medium and wide spacing. The concentration of N was generally higher in the leaves of widely spaced crop; although manuring with N increased the nitrogen content of the leaves, the difference between the N contents of the leaves under close and wide spacing was still maintained. It was concluded that N was a limiting factor in the Gujarat soils and the superiority of the widely spaced crop could be attributed to the larger soil mass available for exploration of nutrients by roots.

Biswas⁷ reviewed the present state of our knowledge on trace elements in soil and plant.

Solomon⁸ determined the osmotic pressure of the host (Sorghum) and parasite (Striga) in relation to the nutrition of the host. It was found that the severity of attack (as estimated by the number of plants of the parasite germinating) was the highest at

5. Lal, K. N., Rao, M. S. S. and De, R. (1952), Proc. Nat. Inst. Sci., India, **18**, 603.

6. Dastur, R. H. and Gopani, D. D. (1952), Indian J. Agr. Sci., **22**, 113.

7. Biswas, T. D. (1952), Science and Culture, **18**, 173.

8. Solomon, S. (1952), Proc. Indian Acad. Sci., **35** B, 122.

the lower concentration and the lowest at the higher concentration of the nutrient solution. Similarly the reduction in grain yield of sorghum was the greatest at the lower concentration. The osmotic pressure of the leaf cells of the parasite was always much greater than that of host at the lower concentration but at the higher concentration the leaves of the host and the parasite had practically the same osmotic pressure. In another paper the same author⁹ described the influence of temperature and moisture on the germination and growth of *S. lutea* and *S. densiflora*. At 35°C and 30%, moisture the number of striga plants attacking a single host was found to be the largest.

Developmental Physiology :

Chinoy and Nanda¹⁰ attempted to ascertain as to how far the effect of long day could be correlated with the uptake of nutrients N, P and K. Rates of uptake of N and K were higher under normal day, whereas that of P was greater under long day. The rates of uptake of the three nutrients were the slowest under short day. It appeared from their data that the course of absorption of nutrients was determined more or less by the pattern of growth imposed by photoperiod.

Sen Gupta and Sen¹¹ studied the photoperiodic behaviour of two species of jute, viz., *Corchorus capsularis* (D 154) and *C. olitorius*. The latter species flowered in 21 days under a ten-hour photoperiod as against 126 days required under the normal day length. *C. capsularis* flowered in 33.6 days under a similar photoperiod whereas under the normal day length 131 days were required. Both these species were, therefore, classified as short-day. Plants of both the species subjected to a dark period in the evening grew better and flowered earlier than those treated similarly in the morning. Fourteen and twenty-one photo inductive cycles of 10 hours of light and 14 hours of darkness, were required to induce flowering in *C. olitorius* and *C. capsularis* respectively.

9. Solomon, S. (1952), Proc. Indian Acad. Sci., **36** B, 198.

10. Chinoy, J. J. and Nanda, K. K. (1952), *Physiologia Plantarum*, **5**, 11.

11. Sen Gupta, J. C. and Sen, G. (1952). *Indian J. Agr. Sci.*, **22**, 1.

Dikshit and Singh¹² vernalized seeds of an early large-drum head variety of cabbage at two different temperatures, viz. 32° and 45°F for 4 weeks, and found that plants from seeds treated at 45°F as well as untreated, failed to form seed, although buds were found under the former treatment 200 days after transplanting. The plants from seeds vernalized at 32°F however flowered and produced seeds.

Talukdar¹³ studied the effect of 5 different photoperiods of 8, 10, 12, 14, and 16 hours' duration, respectively on variety C 12 of *Crotalaria juncea* and found the vegetative phase to be considerably prolonged under a 14-hour day and flowering inhibited, under a 16-hour day.

Dikshit¹⁴ studied the response of a variety of pea, N. P. 29 to vernalisation at 45°F for 4, 6 and 8 weeks, respectively. Flowering was not particularly hastened by any of these treatments. The number of root nodules appeared to increase under the treatment with a duration of four weeks.

Choudhri and Prasad¹⁵ found increase in height and vine spread, in size and number of leaves and in fruit production in "Early Market" and "Large Red" varieties of tomato as a result of continuous exposure to light.

Talukdar¹⁶ found the variety N. P. 5 of *Hibiscus sabdariffa*, L. to be a short-day plant flowering earlier by 53 days under a 10-hour photoperiod than under normal day length which varied from 12 to 13 hours (time to flower being 122 days).

Growth Regulators:

Saptharishi and Azariah¹⁷ reported that the use of methyl ester of naphthaleneacetic acid ('Barsprout-Manuf: Am. Cyanamid & Co.), at the rate of 2 gm. of Barsprout per lb. reduced loss of

12. Dikshit, N. N. and Singh, U. P. (1952), Current Science, **21**, 249.

13. Talukdar, S. (1952), *Ibid.*, **21**, 343.

14. Dikshit, N. N. (1952), *Ibid.*, **21**, 48.

15. Choudhri, R. S. and Prasad, A. (1951-52), J. Sci. Res. Banaras Hindu University, Vol. II.

16. Talukdar, S. (1952), *Nature*, **170**, 458.

17. Saptharishi, K. and Azariah, M. D. (1952), *Madras Agr. J.*, **39**, 342.

weight of potatoes in storage to only 24% as against the loss of 71% under control.

Gopalachari¹⁸ investigated the interaction of auxin and N supply on the growth and yield of paddy grown under sand-culture. N deficiency decreased auxin production in the shoot tip, as estimated by Wents' Pea test. On renewing the supply of N to N-deficient treatments, only vegetative growth increased without benefiting grain yield which was less than that of controls under normal N supply from the beginning. On adding naphthalene-acetic acid to N deficient series the grain yield was found to be equal to that of controls.

Balasubrahmanyam and Kanniyam¹⁹ studied the possibility of propagating cotton vegetatively. They treated cuttings of main stem and symposia with 0.3% indolebutyric acid (Seradix B 2) by applying the powder on the moistened cut end. The yield of seed cotton from seed-propagated plants compared favourably with that from cuttings from main axis one cm. in girth. They suggested that six rooted cuttings of interspecific hybrids, between cultivated races of *G. hirsutum* and *G. barbadense*, planted in the backyards of houses would supply the whole of staple cotton annually consumed in Madras State for the manufacture of fine *Khadi*.

Patil²⁰ found that by soaking grains of wheat (N. P. 4) in a dilute solution of 2, 4-D, prior to sowing, growth as well as yield of the crop was stimulated. The concentrations and duration of treatment found useful, in this connection, were 0.01 p.p.m. for 20 hours, 0.1 p.p.m. for 12 minutes, and 10 p. p. m. for 12 minutes and the first treatment gave about 29% higher yield than the control.

Vijayasaradhy²¹ found that application of raw-rice washings to the culture medium (sand culture) stimulated the growth of the shoot in several varieties of sugarcane.

18. Gopalachari, N. C. (1952), Madras Agr. J., **39**, 437.

19. Balasubrahmanyam, R and Kanniyam, K. (1952), Indian Cott. Grow. Rev., **6**, 184.

20. Patil, S. S. (1952), Poona Agri. Coll. Mag., **43**, 7.

21. Vijayasaradhy, M. (1952), Current Science, **21**, 50.

Kumar and Solomon ²² discussed the role of synthetic hormones in combating weeds of the Bombay State.

Metabolism :

Seshagiri and Sastri ²³ found that *Tamarindus indica*, a non-succulent, displayed some of the characteristics of crassulacean metabolism such as decreasing pH with age and seasonal fluctuations in acidity but no diurnal fluctuations in acidity.

Giri *et al* ²⁴ found by chromatographic technique that leaves of some species of Citrus contained high concentrations of free proline, compared to other amino acids. According to them, dried leaf extract of Sandal leaf (*Santalum album*) contains hydroxy-proline in much higher concentration than other amino acids.

Plant Movements :

Bose, Dutt and Guha-Thakurta ²⁵ studied the pulsating activity of the lateral leaflets of an excised leaf of *Desmodium gyrans*. The pulsating activity of a young leaflet continued for twenty days under normal light when supplied only with tap water. The movement stopped at night. The leaflet, light-green at the time of excision, gradually deepened in colour. Under dark the pulsation continued feebly for about a couple of days only, although glucose was supplied. In the case of a medium aged leaf the pulsating activity continued without any nocturnal break for 3 or 4 days only. They suggested that the continuance of the pulsating activity in the young excised leaf was due to its better capacity to form protein in the light.

Bose ²⁶ reviewed the subject of sensitivity in plants and attempted to show that plants possess primitive sense organs and show behaviour in some ways similar to tropic activities in animals.

22. Kumar, L. S. S. and Solomon, S. (1952), Poona Agri. Coll. Mag., **43**, 61.

23. Seshagiri, P. V. V. and Sastri, R. L. N. (1952), Current Science, **21**, 190.

24. Giri, K. V., Gopalakrishnan, K. S., Radhakrishnan, A. N. and Vaidyanathan, C. S. (1952), Nature, **170**, 579.

25. Bose, D. M., Dutt, B. K. and Guha Thakurta. (1952), Science and Culture, **17**, 276.

26. Bose, D. M. (1952), *Ibid.*, **18**, 161.

Miscellaneous :

Dastur, *et al*²⁷ reported that the red leaf blight of cotton in American upland cottons was produced by different conditions. The development of red pigment at Indore was due to senescence of leaves brought about by depletion of food materials on account of maturation of bolls, while at Gadag (Karnatak Bombay) it was caused by desiccation of the leaf tissues on account of continuous high winds during November-December. The red leaf blight occurred at Indore at fruiting stage and it did not appear to affect adversely the yields. They suggested the growing of tall trees around cotton fields to serve as shelter belts.

Saptharishi and Azariah²⁸ found that weedicide Extra A (Sandoz-containing dinitro-ortho-cresol as active ingredient) proved useful in destroying weeds and increasing yield of straw and grain of *samai* (*Panicum milior Lam*), and suggested that the use of this weedicide would prove economic. Kaul and Raheja²⁹ reviewed the problem of weeds and their control.

Tandon³⁰ compared the morphology and growth of the diploids and autotetraploids of *Brassica campestris* L. var. *Sarson* Prain. Although the height and thickness of the base of the stem were greater in the tetraploid, the ultimate fresh and dry matter produced by the entire plant, excluding the roots, did not materially differ from that of the diploid. Although the seed number per siliqua was less in the tetraploid the seed weight was greater.

Narayanan and Lakshmanan³¹ tested viability of seeds of rice, millets, pulses, oilseeds and cotton with 2, 3, 5-triphenyl tetrazoliumchloride and concluded that this method was helpful in assessing seed viability more expeditiously than by the ordinary germination tests.

27. Dastur, R. H., Singh, K. and Kaiwar, S. R. (1952), Indian Cott. Grow. Rev., **6**, 193.

28. Saptharishi, K. and Azariah, M. D. (1952), Madras Agr. J., **39**, 621.

29. Kaul, R. N. and Raheja, P. C. (1952), Science and culture, **18**, 124.

30. Tandon, S. L. (1952), *Ibid.*, **18**, 40.

31. Narayanan, T. R. and Lakshmanan, S. (1952), Madras Agr. J., **34**, 291.

CHEMISTRY OF PLANT PRODUCTS

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During 1952 the volume of work on plant products as shown by the number of publications, has doubled that of 1951. This is as it should be in a country abounding in forests and vegetation. The fillip that is currently being given to the indigenous system of medicine forms added incentive to investigate plant products. In this connection the first decennial (1941-1951) report ¹ of the Drug Research Laboratory, Jammu-Tawi, an active centre of research on natural drugs, should be read with interest.

The work reviewed here has been classified under the headings (1) oils and fats, (2) essential oils, (3) alkaloids, (4) colouring matters, and (5) other plant products.

Oils and fats:

Though India is one of the largest oil seeds producing countries of the world, her oil-crushing industry has not been developed on efficient lines.² This factor coupled with the fact that considerable portion of edible oils is being utilised for soap and other industries, have led to a shortage of oils for food. The need for exploring the possibility of utilising non-edible seed-oils for soap industry has been repeatedly stressed. It has been shown that mixtures of lauric-acid-rich non-edible fats, castor oil, ground-nut oil and hydrogenated rosin can be used as substitute for cocoanut oil in soap manufacture.³ Investigations on the chemistry of non-edible oils should be a profitable line of work.

The seed kernel of *Steculia urens*, Roxb., has yielded a light yellow non-drying oil ⁴ in 25 % yield having the following characteristics and composition : Sp. gr. (Specific gravity) at 30°C : 0.9143; R. I. (Refractive index) at 30°C : 1.4587 ; S. V. (Saponification

1. Chopra, R. N. (1952), *J. Sci. Ind. Research, India*, **11B**, 239.
2. "Oil and Oilseeds Review", 1951-52 (1952), *Indian Soap J.*, **18**, 4.
3. Aggarwal, J. S. (1952), *Indian Soap J.*, **17**, 163-5.
4. Batra, P. C. (1952), *Proc. Indian Acad. Sci.*, **36A**, 284.

value): 195.8 and I. V. (Iodine value): 74.2. Myristic (4.65), palmitic (17.82), stearic (2.01), lignoceric (1.57), oleic (66.59) and linoleic acid (2.42) as well as resin (4.95) and (unsap.) unsaponifiable (0.55) per cent.

The seed kernel of *Prunus communis* var. *Insititia* Linn., known as *Alubukhara* in Hindusthani has yielded a light yellow, pleasant smelling oil⁵ in 39.11% yield having the following characteristics and composition: Sp. Gr. at 18.5°C: 0.912; R. I. at 18.5°C: 1.471; S. V.: 191.8 and I. V. 90.73. Lauric (0.61), myristic (3.08), palmitic (0.52), stearic (4.39), arachidic (6.01), oleic (64.39) and linoleic acid (19.44) as well as unsap. (1.56%).

The black seeds from the fruits of *Mallotus philippinensis*, Muel-Arg., commonly known as *Kamla* in Hindi and *Rohini* or *Raini* in Kumaon and Dehra Dun districts have yielded a rapid drying oil⁶ in 22 to 24% yield comprising the glycerides of oleic (28.6), linoleic (2.4), poly-ethenoid keto-C₁₈-acid (25.7), isomeric eleostearic acid (38.4) and saturated acids, stearic and lower (4.9) per cent. These findings are different from those reported previously.^{7,8} In continuation of their work on this oil, Gupta, *et al*⁹ have shown that α -kamloenic acid, C₁₈H₃₀O₃, m. p. 78-79°C, is isomerised to β -kamloenic acid, m. p. 90.91°C on exposure to ultra-violet light. The acid has been identified as ω -hydroxy-octadeca- $\Delta^{9,11,13}$ -trienic acid. Both the α - and β -isomeric acids give ω -hydroxy stearic acid on hydrogenation.

The pale yellow semi-drying oil¹⁰ obtained in 9:21% yield from the seeds of *Abutilon indicum*, G. Don, (*Kanghi* in Hindi)

5. Dhingra, D. R. and Dhingra, S. N. (1952), Indian Soap J., **18**, 187.

6. Puntambekar, S. V. (1952), Proc. Indian Acad. Sci., **35A**, 57.

7. Aggarwal, J. S., Bhatnagar, S. S., Prakash Narain and Karimulla, (1948), J. Sci. Ind. Research, **7**, 136.

8. Gupta, S. C., Sharma, V. N. and Aggarwal, J. S. (1951), *ibid.*, **10B**, 76, cf. Annual Review of Biochemical and Allied Research (India), (1951), **22**.

9. Gupta, S. C., Sharma, V. N. and Aggarwal, J. S. (1952), J. Sci. Ind. Research India, **11B**, 463.

10. Joshi, S. S. and Gambhir, I. R. (1952), J. Indian Chem. Soc., **29**, 451.

comprises glycerides of linolenic (6.8), linolic (26.7), oleic (41.3), palmitic (5.1) and stearic acid (11.2) as well as unsap. (2.32) %. Its characteristics are: Sp. gr. at 18°C : 0.9237 : R. I. at 18°C : 1.4758 ; S. V. 193.2 and I. V., 100.3. Alcohol extract of defatted seeds contains 1.6 per cent raffinose.

The fatty acid composition of oil¹¹ from soya beans cultivated in Bangalore is: palmitic (11.1), stearic (3.2), oleic (29.8), linoleic (52.1) and linolenic (3.73) per cent by moles. Its glyceride structure is: GS₂U (14.6), GSU₂ (12.5) and GU₃ (72.9) per cent by moles.

The seed oil of *Jatropha curcas* Linn. comprises glycerides of myristic (0.9), palmitic (17.3), stearic (6.4), oleic (53.5) and linoleic acid (21.9) per cent. Its sulphation and cold saponification, alone and in admixture with castor or cocoanut oil have been studied. Two greenish products (not yet characterised) have been isolated from the curcas bark by extraction with alcohol and chloroform.¹²

The greenish yellow oil¹³ obtained in 17.82% yield from the seeds of *Ocimum sanctum* Linn. (*Tulsi*) has the following characteristics and composition; Sp. gr. at 30°C : 0.9063 : R. I. at 30°C : 1.4789 ; S. V., 181.65 ; and I. V. 173.0, palmitic (6.9), stearic (2.1), linolenic (15.7), linoleic (66.1) and oleic acid (9.0) as well as unsap. (2.32) per cent.

The constituent acids of the heart-wood oil¹⁴ of *Dalbergia sissoo*, Roxb., obtained in 5.35% yield are: myristic (5.56), palmitic (31.79), stearic (24.33), arachidic (19.37), linoleic (10.81) and oleic (9.40 per cent). The characteristics of the oil are: Sp. gr. at 50° : 0.9132 ; R. I. at 20°C : 1.5311 ; S. V., 192.50 and I. V., 31.27.

The lacquer forming substance from the different parts of

11. Venkatasubramanian, T. A. (1952). J. Sci. Ind. Research India, 11B, 132.

12. Vyas, M. T. and Desai, C. M. (1952). J. Indian Chem. Soc., Ind. and News Edn., XV, 68 and 74.

13. Patwardhan, V. A. and Nadkarni, G. B. (1952). Current Sci., 21, 68.

14. Kathpalia, Y. P. and Dutt, S. (1952). Indian Soap J., 17, 235.

lacquer bearing trees *Holigarna arnottiana*, Hook, F., of Travancore, has been identified as laccol, $C_{23}H_{36}O_2$ (3-heptadecadienyl catechol). The laccol free kernel oil consists of glycerides of palmitic, stearic, oleic and linoleic acids.¹⁵ The bark exudation of *Semecarpus travancorica*, Bed, contains 21% laccol.¹⁶

Taste-and odour-free neem oil (*Melia azadirachta*) which would be a potential raw material for soap and allied industries, comprises glycerides of arachidic (1.7), myristic (2.4), stearic (10.2), palmitic (16.8), oleic (59.9) and linoleic acid (8.3) per cent.¹⁷

From a study of the composition and properties of various *vanaspati*-hydrogenated oil products—and their corresponding crudes, it has been shown that: (1) both ground-nut and sesame oils vary considerably in their constants and composition; (2) many of the unrefined oils have high free fatty acid value, (3) *vanaspati* has high *iso-oleic* acid content (20-35%) and low linoleic acid content (2.5%); (4) nickel and phosphatide contents of *vanaspati* vary between 0.1 and 0.5 parts per million and 0.001 and 0.005% respectively and (5) market samples of *vanaspati* have high Ni-content.¹⁸ Baudouin test as applied to *vanaspati* has been shown to be qualitative only and not quantitative in that the intensity of coloration is not related to the actual amount of sesame oil present.¹⁹

Crude sesame oil has been reported to afford increased stabilization to simple and carotene containing *vanaspati*; and also to give the greatest colour intensity to Baudouin test.²⁰

Iso-oleic acids present in hydrogenated fats e.g., *vanaspati* have been identified by paper chromatography.²¹ The mixture of dibasic acids separated through vacuum distillation is spotted in

15. Nair, G. V., Poti, A. N. and Pillay, P. P. (1952), *J. Sci. Ind. Research*, **11B**, 294.

16. *Idem*, (1952), *Ibid.*, **11B**, 298.

17. Mitra, C. (1952), *Indian Soap J.*, **17**, 281.

18. Belekar, G. K., Bhole, P. T. and Kane J. G. (1952), *J. Sci. Ind. Research India*, **11B**, 140.

19. Bhatnagar, R. K. and Dutt, S. (1952), *Indian Soap J.*, **18**, 196.

20. Roy, B. R. (1952), *J. Indian Chem. Soc. Ind. and News Edn.*, **15**, 171.

21. Phatak, S. S., Mahadevan, A. A. and Patwarthan, V. N. (1952),

paper in the form of its solution in ammonia along with the ammonium salts of pure acids and the chromatogram developed in the usual manner.²²

A simplified procedure for the determination of hypochlorous acid value of oils has been described.²³ The fatty acids of sesame and linseed oils have been separated through their urea adducts.²⁴ In a general article on the chemistry of fatty acids, the different unit processes as applied to fatty chemistry, have been described.²⁵ Kartha²⁶ has described the determination of melting and solidifying points of mixtures of fully saturated and unsaturated glycerides and of saturated and unsaturated fatty acids.

Application of bromide-bromate test to mustard oil admixed with graded quantities of argemone oil and matching the colour developed in the Lovibond tintometer has shown that with increasing concentration of argemone oil the red unit increased almost proportionately.²⁷

The possibility of commercial production of drying oils for paint and varnish industry from tobacco and safflower seed oils has been indicated in a non-technical note.²⁸

By extracting castor oil with petrol (b.p. 30-60°C) tri-ricinolein has been prepared in almost quantitative yield; its saponification has given ricinoleic acid of high purity.²⁹

The conditions for the maximum formation of 12-hydroxy-stearic acid and stearic acid by the hydrogenation of castor oil in the presence of nickel catalyst have been established. Low temperatures (100-150°C) and high pressures (200 lb./sq. in.) retard

- 22. Reid, R. L. and Lederer, M. (1951), *Biochem. J.*, **50**, 60.
- 23. Basu, S. K. (1952), *Indian Soap J.*, **17**, 216.
- 24. Mehta, T. N., Rao, C. V. N., Lingam, D. N., Shah, S. N. and Prabhu, G. S. (1952), *J. Indian Chem. Soc. Ind. and News Edn.*, **XV**, 97.
- 25. Mehta, T. N. (1952), *Indian Soap J.*, **17**, 201.
- 26. Kartha, A. R. S. (1952), *J. Sci. Ind. Research India*, **11A**, 354.
- 27. Mitra, S. N., Chakravarti, S. C. and Soni, A. B. (1952), *Science and Culture*, **17**, 522.
- 28. (1952) *J. Sci. Ind. Research India*, **11A**, 109.
- 29. Acharya, K. T. and Saletore, S. A. (1952), *J. Sci. Ind. Research India*, **11B**, 471.

the reduction of the OH-group while at high temperature (250°C) and low pressures (70-75 lbs./sq. in.) almost complete dehydroxylation is effected.³⁰

The effect of time, concentration and of molar ratios of sulphuric acid on the sulphation of oleic acid have been studied.³¹

Arachis oil has been separated into 2 parts by passing through an Al₂O₃ column, one comprising acid-free glycerides, oxidised bodies and unsaponifiable matter and the other containing non-glyceride constituents.³²

Lime juice has been shown to afford protection to vegetable oils against rancidity.³³ Metals and alloys have been shown to adversely affect the storage, the decreasing order of stability being silver, stainless steel, aluminium, iron, zinc, tin, brass, copper and lead.³⁴

A plea has been made for the proper utilization of wastes from the various processes involved in the vegetable oil industry.³⁵ Average composition of the spent Ni-catalyst from *vanaspati* factories is: fat, 75.1; Ni, 8.12; Fe: 1.45; acid insolubles, 15.04 and ash 29.95 per cent. A method for the recovery of Ni by digesting the spent catalyst with sulphuric-nitric acid mixture has been developed. A recovery of 93 to 98% is reported.³⁶

Another method consists in (1) burning off the free oil in the press cake containing spent Ni-catalyst (2) conversion of Ni into its sulphide by fusion with Na₂SO₄, (3) conversion of the sulphide to monoxide and (4) conversion of Ni-oxide into active Ni by the

30. Gupta, S. S. and Aggarwal, J. S. (1952), J. Sci. Ind. Research India, **11B**, 303.

31. Mehta, T. N., Rao, C. V. N. and Rao, B. Y. (1952), J. Indian Chem. Soc., Ind. and News Edn., **15**, 111.

32. Sen Gupta, M. L. and Basu, U. P. (1952), J. Indian Chem. Soc. Ind. and News Edn., **XV**, 39.

33. Nair, P. V., Philip, C. J. and Ramakrishna, T. A. (1952), Science and Culture, **17**, 295.

34. Husain, S. M. and Saletore, S. A. (1952), Indian Soap J., **18**, 192.

35. Desikachar, N., Subba Rao, T. V., Venugopal, T. and Nambiar, P. S. R. (1952), Indian Soap J., **17**, 289.

36. Belekar, G. K., Kane, J. G. and Sahani, H. S. (1952), J. Sci. Ind. Research India, **V, 11B**, 28.

reduction of its carbonate (obtained through its sulphate) with hydrogen at 300-325°C.³⁷ During an investigation on utilization of oil refinery refuse, data on the tocopherol content of number of oils and fats have been recorded.³⁸ Utilization of oil cakes, seed hulls and other co-products of vegetable oils and oil seeds has been discussed.³⁹ *l*-Lysine content of some oils and cakes has been determined⁴⁰ by the decarboxylase method of Gale.^{41,42}

Essential Oils

Steam distillation of the plants of the Mexican variety of *Hymenatherum tenhifolium*, Cass, cultivated in Bangalore has given an oil (Sp. gr. at 24°C: 0.813; R. I. at 24.5°C, 1.4712; Optical rotation-5.16°) in an yield of 0.12%. The oil contains *hymenatherene*, a new acyclic monoterpene in 50% yield.⁴³

Leaves, twigs and flowers of *Hyptis suaveolens*, Poit, have given an oil (Sp. gr. at 24°C, 0.8824, R. I. at 25°, 1.4848; optical rotation-4.1°) in an yield varying from 0.042 to 0.079% on the weight of undried plant. The oil distils between 155° and 270°C and contains; *l*-sabinene (31), *d*-limonene (12) azulenic sesquiterpene (17), and unidentified sesquiterpenes and sesquiterpene alcohol (40) per cent.⁴⁴

Ocimum gratissimum, Roxb; cultivated in Bangalore from seeds of U.S.S.R. origin, has given an oil (Sp. gr. at 23°C, 0.9395; R. I. at 23°C, 1.5132; optical rotation,—18.1°) in an yield of 0.53% on the weight of dried herb, containing ocimene (15) eugenol (16.8) and unidentified alcohols (10) per cent.⁴⁵

Ocimum killimanjaricum, Guerka, grown in Bangalore from South African seeds, has given an oil in an yield of 3.3% on the

- 37. Ramaswami, S. (1952), Indian Soap J., **18**, 20.
- 38. Verma, J. P. (1952), Indian Soap J., **18**, 55.
- 39. Subba Rao, T. V. (1952), *Ibid.*, **18**, 90.
- 40. Govindarajan, V. S. and Ramachandran, R. V. (1952), J. Sci. Ind. Research India, **11B**, 77.
- 41. Gale, E. F. (1945), Biochem. J., **36**, 46.
- 42. Gale, E. F. and Epps, H. M. R. (1944), *Ibid.*, **38**, 232.
- 43. Nayak, U. G., Sukh Dev. and Guha, P. C. (1952), J. Indian Chem. Soc. **29**, 23.
- 44. Nayak, U. G. and Guha, P. C. (1952), J. Indian Chem. Soc., **29**, 180.
- 45. *Idem*, (1952), *Ibid.*, **29**, 203.

weight of dried plants. The oil contains *d*- α -pinene (10), *d*-limonene (6), terpinolene (5) and *d*-camphor (70) per cent. This oil should be a good source for natural camphor.⁴⁶ A variety of this cultivated in Travancore has yielded 62.13% of camphor.⁴⁷ Travancore Eucalyptus oil [Sp. gr. at 30°C, 0.8776; R. I. at 30°C, 1.4689; specific rotation, +20.14] contains *d*- α -pinene (60) cineol (28) per cent as also traces of terpineol and aromadendrene.⁴⁸

Mukherji⁴⁹ has suggested that if citrus fruits and flowers which are now being wasted in Assam and Nagpur could be processed for isolation of the oils, an export industry could possibly be built up.

The essential oil⁵⁰ [yield 0.24% Sp. gr. at 20°C, 0.9183; R. I. at 20°C, 1.4977; rotation, nil] from the heart wood of *Dalbergia sissoo* Roxb., contains bisabolene (9.98) and *dl*-nerolidol (66.4) per cent.

Travancore vetiver oil⁵¹ obtained in 0.45% yield has the following characteristics: Sp. gr. at 30°C, 1.0102; R. I. at 30°C, 1.5180. A survey of Indian vetiver oil industry with special reference to Uttar Pradesh has been made.⁵²

The Indian (East India) lemon grass oil from *Cymbopogon flexuosus* Stapf, differs from the West Indian variety from *Cymbopogon citratus* in that the latter does not give a clear solution with 70% alcohol and has a lower citral content. The latter also contains myrcene and aldehydes other than citral.⁵³

The oil [Sp. gr. at 24°C, 0.8999; R. I. at 22°C, 1.990; optical rotation, -9.16] obtained in 46.5% yield from the oleo-resin of *Dipterocarpus indicus*, Bedd, has been shown to contain humulene, β -caryophyllene, a bicyclic sesquiterpene hydrocarbon and a sesquiterpene alcohol, the latter two giving cadalene on dehydro-

46. Nayak, U. G. and Guha, P. C. (1952), J. Indian Chem. Soc., **29**, 112.

47. Nair, K. N. G. and Varier, N. S. (1952), Indian Soap J., **18**, 53.

48. *Idem*, (1952), *Ibid.*, **18**, 17.

49. Mukherji, B. K. (1952) *Ibid.*, **18**, 125.

50. Kathpalia, Y. P. and Dutt, S. (1952), *Ibid.*, **17**, 285.

51. Nair, K. N. G. and Varier, N. S. (1952), *Ibid.*, **17**, 288.

52. Dhingra, D. R., Gupta, G. N. and Ganesh Chandra, (1952), *Ibid.*,

18, 77.

53. Nair, K. N. G. and Varier, N. S. (1952), *Ibid.*, **17**, 229.

genation.⁵⁴ The caryophyllene fraction gave a maleic anhydride adduct of m. p. 180-182°C in addition to the one with m. p. 98°C. The infra red spectrum of the higher melting adduct has indicated the presence of an exocyclic double bond and a grouping $>C=CHR$ besides carbonyl groups.⁵⁵

Lansium annamalayanum, Bedd, gives an oil [Sp. gr. at 25°C, 0.8978; R. I. at 24°C, 1.4950; optical rotation in 1% chloroform solution, -128°] in 2.1 % yield containing bisabolene and two new sesquiterpenes α -and β -chigadmarenes.⁵⁶ α -Chigadmarene has been shown to belong to S-guaiazulene family.⁵⁷

Piper cubeba, Linn. oil [Sp. gr. at 25°C, 0.8994; R. I. at 25°C, 1.4885; optical rotation, -10.7°] obtained in 5.8% yield contains about 50% of sesquiterpenes belonging to cadiene family.^{58,59}

Aromatization of 3-carene from *Pinus longifolia* Roxb. oil to p-cymene is catalysed by trichloracetic acid.⁶⁰

Alkaloids:

The leaves of *Physochlaina praealta* contain 0.01% of hyoscine,⁶¹ m.p. 204-205°C, in addition to hyoscyamine,⁶² m.p. 165°C. An optically inactive alkaloid, rutacin ($C_{14}H_{13}O_4N$, m.p. 176°C) and a sterol, aegelin ($C_{18}H_{18}O_4$ m.p. 175°C) have been isolated from the leaves of *Aegle marmelos*, Correa.⁶³ Rutacin

54. Krishna Rao, G. S., Sukh Dev and Guha, P. C. (1952), J. Indian Chem. Soc., **29**, 598.

55. *Idem*, (1952), *Ibid.*, **29**, 598.

56. Somasekar Rao, A., Dutta, K. B., Sukh Dev. and Guha, P. C. (1952), *Ibid.*, **29**, 604.

57. *Idem*, (1952), *Ibid.*, **29**, 620.

58. Razdan, R. K. and Bhattacharyya, S. C. (1952), Science and Culture, **18**, 148.

59. *Idem*, (1922), Current Sci., **21**, 68.

60. Verghese, J. and Yeddanapalli, L. M. (1952), J. Sci. Ind. Research India, **11B**, 36.

61. Handa, K. L. and Channa, O. N. (1952), J. Sci. Ind. Research India, **11B**, 505.

62. Handa, K. L., Nazir, B. N., Chopra, I. C. and Jamwal, K. S. (1951), *Ibid.*, **10B**, 182. Handa, K. L., *Ibid.*, (1951), **10B**, 234.

63. Asima Chatterjee (Nee Mukherjee), and Sukumar Bose, (1952), J. Indian Chem. Soc., **29**, 425.

has been identified with skimmianine.⁶⁴ Alcoholic extract of *Oldenlandia biflora* plants has yielded two new alkaloids,⁶⁵ biflorine m.p. 206°C and biflorone m.p. 98°C.

Out of the six alkaloids isolated from *Withania somnifera*, one has been identified as nicotine and the remaining five have been named: somniferine (m. p. 185-87°C) somniferinine (m. p. 120°C), withanine (m. p. 87-88°C), withananine (m. p. 35-40°C) and withaninine (m. p. 90-95°C).⁶⁶

In addition to berberine and jatrorrhizine, a new alkaloid, 1-himanthine ($C_{37}H_{40}O_6N_2$, m.p. 206-207°C) isomeric with oxyacanthine and berbamine has been isolated from the stem-bark of *Berberis himalaica*, Ahrendt. Berbamine, berberine, palmatine and jatrorrhizine have been isolated from *Berberis tinctoria*, Leschenault.⁶⁷

Two water soluble alkaloids (m. p. 294°C and m. p. 194°C) have been isolated from *Astercantha longifolia*, Nees.⁶⁸ Two alkaloids (1) pentaphyllene, $C_{14}H_{13}O_4N$, m. p. 175-76°C (0.03% yield) and (2) glycosminin, m. p. 225°C (0.003% yield) have been isolated from *glycosmis pentaphylla*, Correa, commonly known as tooth-brush plant. Pentaphyllene has been identified with skimmianine.⁶⁹ Two alkaloids, hayatin, m. p. 303°C, $C_{18}H_{15}O_3$ $\begin{matrix} OCH \\ < \\ NCH_3 \end{matrix}$ and hyatinin, m. p. 163°C, as well as quercitol and sterol have been isolated from the roots of *Cissampelos pareira*, Linn.⁷⁰

The rhizomes of *Thalictrum foliolosum*, D. C., known as *mamira* in Hindu medicine have yielded berberine (0.35),

64. Asima Chatterjee and Sukumar Bose (1946) J. Indian Chem. Soc., **23**, 6.

65. Chauhan, R. N. S. and Tiwari, J. D. (1952), *Ibid.*, **29**, 386.

66. Majumdar, D. N. (1952), Current Sci., **21**, 46.

67. Chatterjee, R., Guha, M. P. and Das Gupta, A. K. (1952), J. Indian Chem. Soc., **29**, 921.

68. Basu, N. K. and Gode, K. (1952), Indian J. Pharm., **14**, 212.

69. Asima Chatterjee and Majumdar, S. G. (1952), Science and Culture, **17**, 306.

70. Bhattacharji, S., Sharma, V. N. and Dhar, M. L. (1952), J. Sci. Ind. Research India, **11B**, 81.

palmatine (0.03) and jatrorrhizine ⁷¹ (0.02) per cent but no thalictrine as reported earlier.⁷² While Chatterjee, *et al.*, ⁷³ have shown that the rhizomes of *Coptis teeta*, Wall., from Mishmi Hills, Assam, contain berberine (9.0), coptine (0.08), palmatine (traces), coptisine (0.02) and jatrorrhizine (0.01) per cent, Sawhney and Seshadri ⁷⁴ say that the major alkaloid is umbellatine and not berberine.

By chromatographic fractionation of the total alkaloids from the fresh tubers of *Gloriosa superba*, Linn, colchicine, m. p. 151-52°C and a new alkaloid gloriosine m. p. 248-50°C, $C_{22}H_{25}O_6N$ have been isolated.⁷⁵ Gindarine [$C_{17}H_{13}N(OMe)_4$] and gindarinine [$C_{17}H_9N(OMe)_4$] isolated from the tubers of *Stephania glabra*, Miers, have been shown to be identical with tetrahydropalmatine and palmatine respectively.⁷⁶

From a study of the infra-red absorption spectra, a partial elucidation of the structure of kopsine, m. p. 217-8°C, $C_{22}H_{26}O_4N_2$, isolated from *Kopsia fructosa* has been made. The same alkaloid has been isolated from *Kopsia albiflora*, Linn., obtained from Indian Botanic Gardens, Sibpur.⁷⁷ Physical and chemical properties of rauwolfinine (yield 0.02%, m. p. 235-6°C) from the root of *Rauwolfia serpentina* Benth ⁷⁸ are: molecular formula $C_{19}H_{26}O_2N_2$; methoxy or methylene dioxy groups absent; contains one $>NMe$ group; optical rotation, -34.7; U. V. absorption maxima at 249 $m\mu$ and 292 $m\mu$ and minima at 226 $m\mu$ and 272 $m\mu$; mono acidic base giving a hydrochloride, m. p. 195°C.

71. Chatterjee, R., Guha, M. P. and Chatterjee, A. (1952), *J. Indian Chem. Soc.*, **29**, 371.

72. Vashistha and Siddiqui, (1941), *Ibid.*, **18**, 641.

73. Chatterjee, R., Guha, M. P. and Chatterjee, A. (1952), *Ibid.*, **29**, 97.

74. Sawhney, P. L. and Seshadri, T. R. (1952), *J. Sci. Ind. Research India*, **11B**, 308.

75. Subbaratnam, A. V. (1952), *Ibid.*, **11B**, 446.

76. Chaulhry, G. R., Sharma, V. N. and Dhar, M. L. (1952), *Ibid.*, **11B**, 337.

77. Anil Bhattacharya, (1952), *Science and Culture*, **18**, 293.

78. Bose, S. (1952), *Science and Culture*, **18**, 98. cf. Asima Chatterjee and Bose, S., *Ibid.*, (1951), **17**, 139.

Colouring Matters :

The purple colouring matter of the *jambul* fruit has been shown to be an anthocyanin pigment of the wine-red group. The various colour reactions indicate the possibility of a cyanidin rhamno-glucoside being present.⁷⁹

In the glycosidic flavonoid pigments isolated from the flowers of *Acacia leucophloea*, Willd., myricetin and glucose have been identified.⁸⁰

Chromatographic separation of the colouring matters in turmeric through a silica gel column has shown the presence of the three substances: diferuloyl methane, hydroxy-cinnamoyl-feruloyl methane and dihydroxy-dicinnamoyl methane.⁸¹

Data on hydrogenation, elemental analyses, molecular weights, colour reactions and absorption spectra of morellin and its derivatives have been recorded.⁸²

Other Plant Products :

A non-glucosidal bitter, *malanthin*, m. p. 226°C, $C_{23}H_{33}O_3$ (OCH_3), (0.1 % yield) has been isolated from the stem-bark of *Atlanthus malabarica*, D.C.⁸³

In addition to the fixed oil,⁸⁴ the alcoholic extract of seeds of *Ipomoea muricata* has yielded a resinous product from which two glucosides, *muricatin A*, m. p. 115-118°C, $C_{32}H_{60}O_{11}$, *muricatin B*, m. p. 104-106°C, $C_{30}H_{54}O_{13}$, $1\frac{1}{2}H_2O$, as well as caffeic acid and a wax-like product containing phosphorus have been isolated^{85,86}.

79. Venkateswarlu, G. (1952), J. Indian Chem. Soc., **29**, 434.

80. Mukherjee, S. K. and Murthy, V. V. S. (1952), J. Sci. Ind. Research India, **11B**, 125.

81. Srinivasan, K. R. (1952), Curr. Sci., **21**, 312.

82. Rao, P. L. N. and Verma, S. C. L. (1952), J. Sci. Ind. Research India, **11B**, 206.

83. Rastogi, R. P., Sharma, V. N. and Dhar, M. L. (1952), *Ibid.*, **11B**, 124.

84. Misra, A. L. and Tewari, J. D. (1952), J. Indian Chem. Soc.,

28, 721.

85. *Idem*, (1952), *Ibid.*, **29**, 63.

86. *Idem*, (1952), *Ibid.*, **29**, 430.

While the glycosidic principles of *Digitalis lantana* comprises acetyl digoxin, improperly stored material contains no glycosidic material.⁸⁷

In a general article on heart poisons from plants stress has been laid on the need to explore utilization of *Strophanthus* and *Digitalis* plants for pharmaceutical preparations.⁸⁸

Enhydra fluctuans, Lour., has given an essential oil (0.021%) a non-volatile, non-saponifiable matter (0.47%) and a bitter substance.⁸⁹ The root bark of *Tabernemontana crispa* (Dichotomo) contains a neutral material, m. p., 192-94°C, $C_{12}H_{20}O$, yield, 8%.⁹⁰ A tentative formula has been suggested to the lactone, sikkimotoxin, $C_{23}H_{26}O_8$, obtained from the rhizomes of *Podophyllum sikkimensis*.⁹¹ The following constituents have been isolated from the pulp of *Cassia fistula*: (1) rhein (1:8-dihydroxy-3-carboxy anthraquinone), (2) another anthraquinone derivative, m. p. 250°C, (3) small quantity of volatile oil, and (4) waxy and resinous substances.⁹²

The root bark of *Tephrosia lanceolata*, Grah, contains three crystalline substances; (1) m. p. 187-88°C, $C_{22}H_{22}O_4$, toxic to fish (2) m. p. 135-42°C, non-toxic and (3) m.p. 122°C, $C_{23}H_{14}O_4$, 2 H_2O , less toxic to fish.⁹³

Padmakastin, (the glycoside) and *padmakastein* (the corresponding aglucone) have been isolated from the bark of *Prunus pugettum* (Sanskrit: *Padma kashta*). The aglucone, $C_{16}H_{14}O_5$,

87. Krishnamurthy, G. G. and Ole Gisvold, (1952), J. Amer. Pharm. Assn., Sci. Edn., **XLI**, 152.

88. Chakravarti, J. K. (1952), Science and Culture, **17**, 282.

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has been shown to be dihydroprunatin and is the first *iso* flavanone to be isolated.⁹⁴

Chemical investigations of Indian lichens belonging to the families *Roccella*, *Farmelia*, *Ramalina*, *Teloschistes*, *Caloplaca* and *Usnea* have been reviewed in a general article.⁹⁵ Physcion (2-methyl-4:5-dihydroxy-7-methoxy anthraquinone) m.p. 208-10°C has been isolated in 0.7% yield from *Caloplaca elegans*.⁹⁶ d-Usnic acid, sekikaic acid, d-arabitol and lichenin have been isolated from *Ramalina calicaris*. *Ramalina simensis* contains only d-usnic acid, d-arabitol and lichenin.⁹⁷

Proteins and other nitrogenous constituents of the castor seed have been investigated with reference to their isolation, purification and characterization.⁹⁸⁻¹⁰²

The chief constituents of the edible portion of *Agave vera Cruz* have been shown to be polyfructosans.¹⁰³ Attempts have been made to improve the method of recovery of potassium salts from molasses.¹⁰⁴

Chemical analysis of a number of male-ferns from Kashmir, Chamba and Mussoorie has shown that they can be considered as Indian substitutes for the B. P. and U. S. P. official drug.¹⁰⁵

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Ash percentages of cocoanut shell are 0.67 and 0.46 when ashed at 550°C and 750°C respectively. It contains K₂O (0.226), Na₂O (0.127), CaO (0.017) MgO (0.016), Fe₂O₃ + Al₂O₃ (0.011), P₂O₅ (0.030), SO₃”, (0.139) and Cl’ (0.324) per cent.¹⁰⁶ The ultimate analysis of shell and shell charcoal has given: C, 51.58; H, 5.83; N, 0.145; S, 0.055; Cl: 0.324 and ash 0.49 per cent.¹⁰⁷

Formation of iodoform during iodine absorption by jute cellulose indicates that one of the products of oxidation is a compound containing CH₃ - CO - C E group.¹⁰⁸ The rise of the acid value of jute after its treatment with dilute alkali has been attributed to the breaking of the ester linkage in the hemicellulose.¹⁰⁹ Hydrolytic saccharification of jute sticks has yielded a total of 51.02 per cent of reducing materials calculated as glucose.¹¹⁰ A study of the acidic properties of jute fibre has been made by submitting the fibre to hydrolytic reactions.¹¹¹ *Canna orientalis*, considered as a jute substitute, yields a light green fibre with an average fibre length of 2 inches but differing from top grade jute by its higher lignin, furfural and carbondioxide values and lower a-cellulose content.¹¹² It has been shown that short staple Indian cotton can serve as raw material for the manufacture of cellulose nitrate.¹¹³ Hemicelluloses from the tubers of *Asparagus adscendens* Roxb., have been separated into 2 fractions, A₂ and B₂, comprising xylose, glucose and glucuronic acid in the molecular ratio 2:1:1 and 1:1:2 respectively.¹¹⁴ The two fractions A₂ and B₂

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of hemicelluloses from *Asparagus racemosus*, Willd., consist of glucose and galacturonic acid in the ratio 10:1 and 5:2 respectively.¹¹⁵

Mango seed kernels contain 40-50% starch, 6-12% fat and 12-18% tannin. It is estimated that 140,000 tons of starch may be obtained if this source is tapped.¹¹⁶ Edible starch resembling tapioca starch has been prepared from Indian horse chestnut (*Aesculus indica* Colebr.) in 25% yield.¹¹⁷ Characteristics of starch from the tubers of *Dioscorea bulbifera* Linn.,¹¹⁸ and *Dioscorea hispida* Dennst.¹¹⁹ have been studied.

While Uppal and Mehta¹²⁰ have reported a high yield of saponin from *Sapindus mukorossi*, Gaertn., Gedeon¹²¹ gets only a low yield. A mixture of soapnut saponin and cocoanut oil soap in equal proportions yields a general textile auxiliary superior to the proprietary products in use.¹²² Alcoholic extract of defatted seeds of *Achyranthes aspera* Linn has given a saponin (2% yield) which on hydrolysis yields a sapogenin m.p. 305-306°C, C₂₉H₄₆O, answering the colour reactions of steroids. The sugar moiety of the saponin is glucose.¹²³ The different species of *Asparagus* available in India contain only poor quantities of sapogenin fraction, most of which is sarsapogenin.¹²⁴ A saponin possessing haemolytic activity on red blood corpuscles has been isolated from the seeds of *Albizzia lebbeck*.¹²⁵

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The counter-current method of extraction of avaram bark (*Cassia auriculata*) yields liquor with high concentration of tannins without undesirable dark colour.¹²⁶ p-Nitrophenol has been found to be a good preservative for tannin extracts from *Divi divi*.¹²⁷ Methyl alcohol extracts as much tannin but less of non-tannins, from *myrobalams* and *Divi divi* as that by the official method using water.¹²⁸ Tannin and non-tannin contents of wattle bark¹²⁹ from Nilgiris and iron-wood bark¹³⁰ from Malabar have been determined.

Mucilage (2.3 %) from the tumers of *Asparagus adscendens*, Roxb.¹³¹ contains 10.24 % uronic acid. Its hydrolysate contains glucose, mannose and xylose in the ratio of 4 : 4 : 1. Hydrolysis of the mucilage from *Asparagus racemosus*, Willd.,¹³² yields glucose and aldobionic acid. The hydrolysate of *ketha* gum (*Feronia elephantum*) contains galactose, arabinose and xylose. In the basic salt of the degraded gum, presence of glucuronic and aldobionic acids have been indicated.¹³³

Galenical preparations from Indian squill (*Urginea indica* and *Scilla indica* Roxb) have been found to be less leavo-rotatory than those from European squills.¹³⁴ A modified method for the assay of the bitter principle, *Chirata*, has been suggested.¹³⁵

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| 7 | 23 | transminase | transaminase |
| ," | 24 | <i>Phaseoles</i> | <i>Phaseolus</i> |
| ," | 27 | ketoglutarate | α -ketoglutarate |
| 11 | 27 | ethyl | ethyl |
| 16 | 21 | glycinc | glycine |
| 30 | 1 | Sirsi, Natarajan and Nayak | Sirsi, Kale, Natarajan and Nayak |
| 37 | 25 | Karmakar | Karmarkar |
| 50 | 7 | <i>Phaseolus</i> | <i>Phaseolus</i> |
| 57 | 6 | microbiologically | microbiological |
| 60 | 12 | is | was |
| 83 | 2 | predominately | predominantly |
| ," | 14 | haemorrhage | haemorrhage |
| 84 | 13 | amalignant | a malignant |
| 88 | 7 | Benerjee | Banerjee |
| 91 | 23 | bromsulphathlein | bromsulphathalein |
| 93 | 13 | determing | determining |
| 104 | 15 | 160.0 26.3 | 160.0, 26.3 |
| ," | 20 | interstitial | interstitial |
| 107 | 13 | therapeutic | therapeutic |
| ," | 17 | chemotherapeutic | chemotherapeutic |
| 111 | 22 | tonus | tones |
| 116 | 21 | were in both | was in both |
| 119 | 7 | appara s | apparatus |
| 120 | 14 | celluose- | cellulose- |
| 131 | 25 | were reduced ; | was reduced ; |
| 136 | 5 | non-succulent | non-succulent |
| ," | 22 | nocturnal | nocturnal |
| 138 | 4 | Institue | Institute |
| 140 | 1 | linolic | linoleic |
| 142 | 4 | hypochlorus | hypochlorous |
| 143 | 17 | catalyat | catalyst |

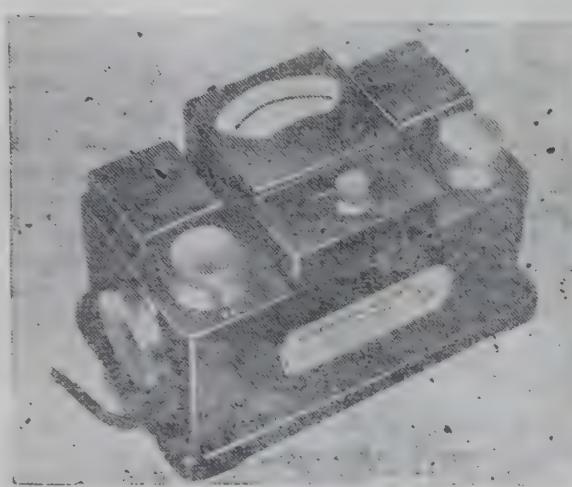
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| 11 | 37, 38 | Airan, A. W. | Airan, J. W. |
| 30 | 40 | Kale, L. | Kale, L. S. |
| 37 | 22 | Karmakar | Karmarkar |
| 70 | 44 | Minet, F. C. | Minnet, F. C. |
| 141 | 21 | Patwarthan, V. N. | Patwardhan, V. N. |
| 19 | 15 | | |
| 20 | 21 | | |
| 21 | 23 | | |
| 28 | 32 | | |
| 31 | 54 | | |
| 32 | 55 | | |
| 64 | 5 | Shrivatsava, D. L. | Shrivastava, D. L. |
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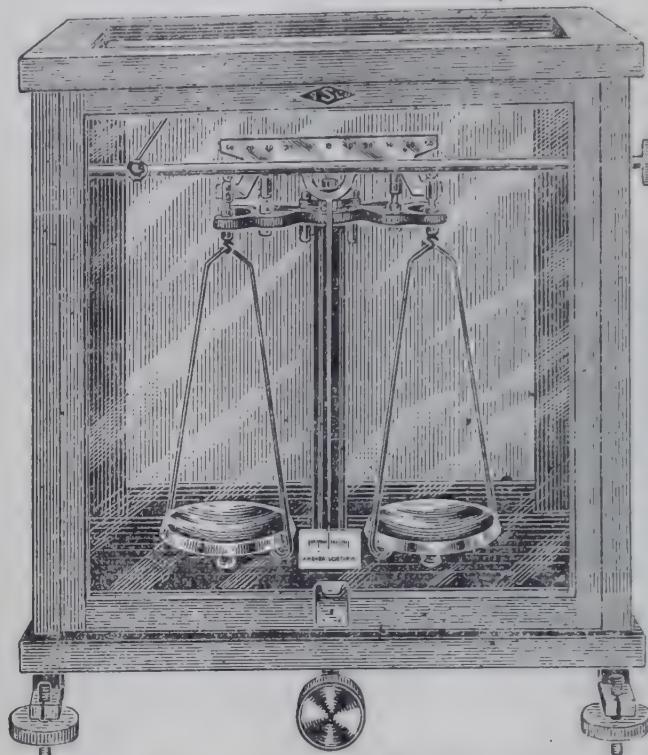
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